Journal by Alexander Graham Bell, From November 7, 1901, to April 29, 1902

TABLES IN DICTATED NOTES VOL. III

PAGE

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1901, Nov. 19 Tuesday Received following notes at 1331 Conn. Ave 1901, Nov. 8 Friday At Beinn Bhreagh

Daedalus Greek mythology — inventor and mechanical genius. Reported inventor of the auger, saw, and other tools. According to tradition he built the labyrinth at Crete, the temple of Apollo at Carnae, and fabricated wings with which he flew from Crete to Sicily. He was the father of Icarus .

(Johnson's Encyclopedia).

Icarus Son of Daedalus — who forgot, according to the old myth, his father's advice on their flight from Crete, and flew so high that the sun melted the wax with which the wings were attached to his shoulders, and he fell down, and was drowned in the sea which after him is called Icarian.

(Johnson's Encyclopedia).

Icaria, or Icarus (Nikaria) an island of the Agean Sea W. of Samos, 15 miles long about — area about 50 sq. miles population of 8,000. As of old — is valued for its pasturage.

(Johnson's Encyclopedia).

Daedalus (Encyc. Brit.) VI p.760 — Legendary representative of carving and sculpture in Greece in time before Homer. His name identical with Greek "to carve", and "carved wings".

Most of tools used in wood-carving and sculpture believed to have been invented by him. "He was the first to open the eyes of statues so that they seemed to look at the spectator, and to separate the legs so that they seemed to walk. A statue of Heracles by him had to be tied to prevent its running away, when the hero, angry at its resemblance to himself, threw a stone at it".

The legend: — The story is that Daedalus "Had fled from Athens after killing his skilful nephew Talus, had gone to Crete in the time of Minos, had there constructed the famous labyrinth, and made a 'chorus' for Adriadne, and a cow for Pasiphae, and had been thrown into prison, but escaped along with his son Icarus by means of wings. Icarus, however, fell into the sea and perished. Daedalus reached Sicily, where, protected by the King against Minos, who pursued him, he is said to have constructed several important works."

Encyc. Brit.

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Daedalus An Athenian — "killed his nephew Talus through jealousy of his talents, and fled with his son Icarus to Crete, where he built the celebrated labyrinth for Minos the king. But, having offended Minos, so that he was imprisoned by him, he made wings of feathers, cemented with wax, for himself and his son, so that they might escape by flight. He gave his son directions to fly neither too low nor too high, but to follow him. Icarus, however, becoming excited forgot his father's advice, and rose so high that the heat of the sun melted the wax of his wings and he fell into the sea near Samos. The island of Icaria, and the Icarian Sea being named after him. Daedalus accomplished his flight in safety. (Encyc. Brit. I, 185). Authority given “Ovid Met. Lib. VIII Fab. III”.

Archytas (Xexutxs) celebrated Greek philosopher, general and mathematician, born in Tarentum. Flourished 400 — 350 B.C. — A Pythagorean in phil. — intimate friend of Plato — whose life he is said to have saved when Dionysius was about to put him to death — His virtue as conspicuous as his ability — Reported to be the first that applied geometry to practical mechanics, and the first to solve the problem of doubling the cube. He was drowned on the coast of Aphalia. Only fragments of his works are extant.

(Johnson's Encyclopedia).

Aeronautics (See Johnson's Encyc). Interesting article.

Aerostatics See Aerodynamics (Johnson's Encyc). only a paragraph.

Flying-Artificial — Interesting Article.

Flying-Machine — An Addendum to Aeronautics (Described de Lome and

Balloon (See aeronautics) Johnson's Encyc.

Flying Short Introd. to (Flying Artificial) Johnson's Encyc.

Aeronautics Enc. Brit. — Good.

Flight Enc. Brit. — Good.

Archytas Enc.Brit. Philosopher 447; his flying dove I, 185.

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Archytas'Flying Dove Archytas of Tarentum is apostrophized by Horace (Ode 28, lib. I). The account of his flying pigeon or dove we owe to Aulus Gellius (Noctes Atticae), who says “that it was the model of a dove or pigeon formed in wood, and so contrived as by a certain mechanical art and power to fly: so nicely was it balanced by weights, and put in motion by hidden and enclosed air”. (Enc. Brit. I, p. 185).

Ancients convinced of impossibility of men being able to fly, and they appear to have made no attempts in this direction at all. Flying an attribute of the Gods or more powerful divinities. (Encyc. Brit.I, 185) (Angels — angelic beings, &c. &c. winged horses and monsters. A.G.B.)

Middle Ages — Superstition — ignorance — fanaticism prevalent. Birds' wings for angels — bats' wings for devils — broomsticks for witches — art of flying was an affair of magic. A. G. B.

Roger Bacon (13th Century) — Quote Dr. Wise's Aeronautics.

Torricelli (Early in 17th Cent.)

Albertus Magnus (Who flourished first half of 13th Century).

Quotation from Astra Castra p. 25: —

“Take one pound of sulphur, two pounds of willow carbon, six pounds of rock salt ground very fine in a marble mortar; place, where you please, in a covering made of flying papyrus to produce thunder. The covering in order to ascend and float away, should be long, graceful, well filled with this fine powder; but to produce thunder, the covering should be short, thick, and half full.”

(Encyc. Brit. I, 185.)

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Attempts at Flying from Encyc. Brit. I, p. 186.

(16th cent.) Italian alchemist (beginning of 16th Century) visited Scotland. “Having constructed a set of wings, composed of various plumage, he undertook from the walls of Stirling Castle to fly through the air to France. This feat he actually attempted but he soon came to the ground, and broke his thigh-bone by the violence of his fall”, &c. Dunbar, the Scottish poet saterized this.

1617 Fleyder, rector of grammar school at Tubingen, delivered a lecture on flying, which he published eleven years afterwards. A poor monk, ambitious to reduce this theory to practice, provided himself with wings; but machine broke down — and falling to ground he broke his legs and perished.

1648 Bishop Wilkins in Mathematical Magick 1648, relates that: —

Elmerus (A monk about Confessor's time) flew by means of wings from a town a distance of more than a furlong.

Another person — flew from St. St. Mark's steeple at Venice

And another — at Nuremburg

A Turk — at Constantinople

Possible to make a long list of such narrations.

1680–81 Borelli's posthumous work De Motu Animalium points out impossibility of man being able by his muscular strength to give motion to wings of sufficient extent to keep him suspended in the air.

From Encyc. Brit. I, 186.

Albert of Saxony , Monk of order of St. Augustine, and commentator on works of Aristotle.

“As fire is more attenuated, and floats above our atmosphere, therefore a small portion of this etherial substance, enclosed in a light balloon globe, would raise it to a certain height, and keep globe, would raise it to a certain height, and keep it suspended in the air; and that, if more air were introduced, the globe would sink like a ship when water enters by a leak”.

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Long afterwards

Francis Mendoza (who d. 1626, ae. 46) embraced this theory.

Casper Schott (Also a Jesuit) adopted same speculation, but replaced the “fire” by the thin etherial substance which he believed floated above our atmosphere.

Similar notions revived at different times.

Alchemical tenets 15th, 16th and 17th cent.

Schott quotes Lauretus Laurus: — Swan's eggs, leather balls, filled with nitre, sulphur or quicksilver, and exposed to sun, ascend.

Hen's eggs filled with dew, &c.

1670 Lana.

1755 Joseph Galien — hugh Noah's Ark filled with etherial air.

Francis Bacon , — obscure.

1783 Montgolfier, Stephen and Joseph.

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LECTURE AND CONCERT In Masonic Hall, BADDECK Friday, November 8th 1st,

Lecture will be delivered by Dr. Graham Bell on Aerial Navigation, by Lantern Slides. The of Dr. Bell as a lecturer, and the new subject lectured on, will make the feature both interesting and instructive.

?nstrumental and Vocal Music by local talent.

Admission 25c.; Reserved seats 35c.; Children 15c. Opens at 7.30.

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1901, Nov. 21 Thursday At 1331 Conn. Ave.

EXTRACT OF LETTER FROM A.G.B. TO M.G.B.

“Beinn Bhreagh Laboratory, Nov. 7. 1901

................Did any one tell you of the awful time we had last week with Susie McCurdy. It was last Saturday I think that Daisy called me while I was in the bath-tub to come and help Susie. Daisy had tried to take a plaster cast of Susie's face — and could not get the plaster mask off. She had soaped Susie's face, I understand, to prevent the plaster from sticking, and had then poured plaster on leaving two small holes at the nostrils to breath through. After letting the thin shell of plaster set and harden she then poured on more plaster to strengthen the mask until poor Susie had a mass of plaster several inches thick over her face — and then it was discovered that Susie's eye-brows and eye-lashes were firmly embedded in plaster — and that the mould adhered to her face in several places. How long they had been working over it before I was called — I do not know — but when I arrived on the scene — there was Susie on her back on a sofa — helpless with a mass of plaster weighing several pounds completely covering her face — and apparently as hard as stone. It went under her chin also up to her neck — decidedly dangerous. She had been crying and her nostrils were beginning to be plugged up.

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“Had to pick it away with a penknife — but this proved very slow laborious work and trying to Susie. Poor George looked like a ghost as he looked on — I thought I would send him to the laboratory for a fine hair saw we have there — by which means I hoped to saw off portions and reduce the thickness of the whole. George thought there was a saw somewhere in the house and went off — soon returning with a meat saw. I then set him to work carefully reducing the thickness of the mass.

Before I was called — Daisy had tried to loosen the mask by pouring in water between the mask and the face — but as the face had been soaped — soapy water got into Susie's eyes causing her great suffering.

We soon succeeded in taking off all the plaster below the nose — thus relieving the mouth. The breathing was then all right — and this also enabled us to administer stimulants — for Susie was in a half fainting condition.

Little by little the plaster was sawn away until nearly every bit had been removed excepting that covering the eyes. George sawed these so that they were cracked into comparatively small pieces: —

George sawing open Susie's eyes.

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“and then Daisy prying the pieces up a little scraped away the under surface of the plaster in which the hairs were imbedded.

We all gave a great sigh of relief when the plaster was completely removed and Susie's eyes were found to be un-injured. Present: — Mrs. Kennan, Daisy, Miss Safford, George McCurdy, and A.G.B. — with Maggie, Mary & Co. — flitting about in the back-ground.

When it was all over we gave Susie a good dose of liquer (is that the way to spell it?) — and put her to bed. The operation of removing the mask lasted about 5-½ hours! Susie went to sleep almost immediately and woke up next morning fresh and bright A.G.B."

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1901, Nov. 22 Friday At 1333 Conn. Ave

Reached Washington yesterday morning, Thursday, Nov. 21.

The following photograph taken by George McCurdy at Beinn Bhreagh has not been put in its proper place or under its proper date. It was the first on a roll developed Nov 13 but George did not remember when it was taken, but guessed it was taken "November". I recognize it, however, as representing an experiment with the three celled hexagonal kite loaded in the center with a heavy brass tube. The photograph undoubtedly was taken on Thursday, October 24, 1901, as a note dated Oct. 25, in my Home Notes, under date Oct. 25, show that these experiments were made the previous date. The kite referred to is shown in photographs taken Oct. 24, see dictated notes p. 447. (Vol. II).

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This kite was converted afterwards into a four-celled hexagonal kite, photographs of which were taken Oct. 26, see p. 448, p. The framework, after the cloth had been removed, is shown in photographs on p. 449, taken Oct. 26.

Three-celled kite shown in photograph p. 447 had cloth removed, and framework photographed on Oct. 26, see photographs on p. 449. The framework was then re-covered converting the kite into the four-celled kite shown on photographs on p. 448, taken Oct 26.

The following photograph taken Nov. 5, shows the framework for a four-celled kite, each cell having a side of 25 cm. The total length of kite being 100 cm., as shown by comparison with a 50 cm. celled kite, 100 cm. long (two-celled)

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This 25 cm. celled kite, when completed, was tried and found to fly well. It was then placed inside a 50 cm. celled kite, making the compound kite shown in the following photograph which was taken Nov. 7, 1901.

This compound kite has been taken as a model, and we employed two men (Mr. Watson and Mr. John Ferguson) to make numerous copies of it. We want to multiply this kite and then fasten these kites together in various ways in a giant compound form.

Before starting upon these kites Mr. Watson and Mr. John Ferguson were employed to make a section of the framework of the gigantic kite proposed for carrying up a man. The object of making this section being to ascertain whether, within the limits of weight allowable, the framework would prove strong enough to support a man. The photograph upon the next page, 465 265 465 p. 265 465 , shows this section as existing on Nov. 15, 1901. Mr. Angus Ferguson stands behind the section so that some idea can be formed of its size relatively to a man. On the right of the picture Mr. Watson is seen at work upon the framework of kites like those shown on p. 264.

In order to test whether the giant frame would be strong enough to support a man the frame was braced by attaching cords to opposite corners and then suspending a board so that it should come about where the man would be expected to sit.

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Mr. Angus Ferguson then sat on the swing, with his feet off the floor, so as to be completely supported by the frame. The following photograph was then taken, Nov. 15, 1901.

The smaller kites on the right show the framework at which Mr. Watson was at work (see p. 265) in a further state of completion, being now covered with cloth and ready for the 467 insertion of the 25 cm. celled kites.

In building a giant hexagonal kite, of which the large pictures (pages 265, 266) show a section, constituting 1 meter of the length of the kite (diameter 4 meters). The above photographs show the section intended to hold a man, and made therefore of stouter and heavier material than would be required in the other sections. Each section will be filled with the smaller kites seen on the bench to the right, which are similar to that on p. 264.

In order to make room for new kites, it has been necessary to destroy a large number of old kites by taking them to pieces, so that the materials may be used over again. The following photographs of the condemned kites, were taken Nov. 7 1901.

The men shown on p. 268 are Mr. Angus Ferguson, on the left; his son, John Ferguson, on the right; and beside him Mr. Watson (the man with the pipe in his mouth.)

In the photograph on p. 269 is Mr. Angus Ferguson and some of the condemned kites.

The photograph on p. 270 shows Mr. Angus Ferguson and his son John Ferguson standing inside giant kites made of bamboo.

468 469 470 471

The sun-parlor at Beinn Bhreagh, taken Nov. 13, 1901.

472

The following photograph shows the model constructed by George McCurdy on Thursday, Oct. 24, 1901, described in these notes, Oct. 26, 1901, see p. 440 (Vol. II), also p. 441. The photograph was taken Nov. 15, 1901

The photographs on p. 273 show experimental frameworks for compound kites having 25 cm. cells, constructed of pieces of wood glued together, designed to save labor in construction.

473 474

The Santos-Dumont Kite shown on pp. 355, 356, 357 and 358 was taken to pieces as the cells were not of the proper size to combine with any of our other cells. If I remember rightly they were 60 cm. cells. The material was used to construct a framework carrying six cells 50 cm. × 25 cm. shown in photograph below, taken Nov. 7. The longitudinal sticks were brought together to a point, making a Santos Dumont bow, but it does not show well in the photograph against the background of the boat-house. They are not brought together at the stern.

The above frame was constructed as a support to which could be fastened a large number of cells arranged in various experimental ways. The photograph at the top of p. 275 shows a number of these cells on the ground and Mr. Ferguson holds in his hand a few sides that could be used to complete any 475 form desired.

The following photograph illustrate the way in which these cells can be combined into various compound forms.

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In the following photographs (taken Nov. 15, 1901) a few of these cells are shown attached to the frame, forming two tiers of cells. The whole structure was extremely suggestive if a giant bird. The center of gravity came within the second tier of cells about 8 cm. in front of the back edge, and not far from the top of the body framework and above it.

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On Friday, Nov. 15, the bird like kite shown on the preceding page was tried in a good breeze. It proved to be the lightest flying kite so far constructed. In spite of the heavy body the flying weight was less that 300 grams per sq. meter of surface (I think 295 grams) but as the Laboratory Notes have been left at Beinn Bhreagh I cannot tell exactly. The kite was flown by a bridle from the front of the first cell

The kite went up well and flew beautifully steadily but stern somewhat depressed as shown in the above diagram.

The second tier of cells was then transferred backwards one place as shown in the following diagram

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With this arrangement of cells the kite flew with the body nearly horizontal. The lifting power was so great that George McCurdy was carried up into the air as the kite rose. Fortunately he let go when he had been lifted about three feet off the ground, otherwise serious accident might have occurred, for the framework was not strong enough to support his weight and would undoubtedly have broken. No difficulty was experienced in bringing the kite down by running down the line. The kite was then flown with the cord attached to the bow

The kite flew beautifully, steadily, with the body almost horizontal. In bringing the kite down the body remained horizontal and Mr. Ferguson walked right up to the bow without any part of the kite touching the ground. He took hold of the bow with his hand and had to push it down to the ground with the aid of another man. This was the last experiment made at Beinn Bhreagh before I left.

I left Baddeck Sat. morning Nov. 16, 1901. A.G.B.

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1901, Nov. 25 Monday At 1331 Conn. Ave.

I left Baddeck Saturday morning Nov. 16, 1901, reaching Halifax the same night. I sailed from Halifax Saturday night, Nov. 16, 1901, by steamship Bona Vista , reaching Boston about noon on Monday. While in Boston I saw Mr. Eustace Hubbard, Mr. James Hubbard, Miss Fuller and her teachers, Helen Keller and Miss Sullivan, and Mrs. Pratt. Also visited establishments advertising the sale of aluminum. Ordered, through Mr. Richie, of Wilkinson's establishment, some samples of the thinnest sheet aluminum manufactured. Left Boston by mid-night train on Tuesday, Nov. 19, reaching Gilsey House in New York early Wednesday morning, Nov. 20. Mr. F. W. Booth met me at the Gilsey House and took breakfast with me. We then went out for a drive together in search of Mr. Balzer, and his rotary engine. we were unable to find him, although we found where he had lived until within a month ago. The people did not know his present address, but referred us to the butcher on the other side of the street. The butcher seemed to be anxious himself to find his address, as he owed him $50, and referred us to the grocer next door. The grocer too seemed to be anxious to have his exact address, as he had left without paying the grocer's bill. They told us approximately that he lived near Bedford Park and a cross street, but we came to the conclusion that as Mr. Balzer might not care to let the butcher and the grocer know exactly where he lived, it might be possible that they had the wrong address. We concluded that 480 he was more likely to give me a correct to give a correct address, as he was seeking employment from me, so we determined to hunt up the address telegraphed from Washington. It turned out to be an empty field, with no houses or buildings within a quarter of a mile on either side. We went to the nearest place that looked like a work shop and made enquiries as to whether anyone knew of a Mr. Balzer, and a rotary engine that he had invented, and a brick building was pointed out to us, which was said to be the place where we could find out all about rotary engines. We went there, and a middle aged man came to the door. He did not know whether Mr. Balzer was in the house or not, but he could give us all the information about a rotary engine which was of no use or value, he said. So we went down to his workshop, which was full of curious looking contrivances. The man was evidently a regular crank. He showed us a portion of a rotary engine which he said was his invention — that wouldn't work — and tried to explain the reason why no rotary engine could work.

I explained to him that what we were after was Mr. Balzer himself, and did he know of such a man any where or could help us to find his address. Well, he said that a Mr. Balzer had been working in his workshop at one time, but he didn't know where he was now, but referred us to a firm of pattern makers, who had employed him at one time.

As we were driving off to visit the pattern makers, — about an hour's drive away — it occurred to me that we 481 might reach them by telephone, so we called at a public pay station, and found that the firm did have a telephone.

I talked with the manager, who stated that he didn't know where Mr. Balzer was now, but I might find out perhaps at the BALZER MOTER COMPANY. This was what we wanted, and we drove to the Balzer Mo??tor Company, and saw Mr. Cary, the Manager, an intelligent man. This firm has been organized to construct motors after Balzer's design.

Mr. Balzer, it seems, is a man between 40 and 45 years of age, who has given himself up to dissipation, and the firm know nothing about his whereabouts at the present time. They had just completed a motor for use on an automobile, and were about th try it, so were invited in to see the first trial.

After a long delay in getting it properly started, it went off with such velocity that Mr. Booth made haste to get behind a pillar. It certainly gave evidences of very great power with little weight.

All engines require a heavy balance wheel, which, of course, would add enormously to any engine intended for use in a flying machine. Mr. Balzer's engine is unique in this that the engine itself is its own balance wheel. The whole engine rotates. I obtained particulars concerning the engine Mr. Balzer had made for Prof. Langley , and found that if any such engine was to be made for me that the Balzer Motor Co. would be the manufacturers, and that the manager, Mr. Cary would be the proper man to apply to.

The President of the Company is a Mr. Humpheries, and I will correspond with him upon the subject. Mr. Balzer the 482 inventor, is evidently an unreliable man, and his dissipated habits would preclude all idea of my making an engagement with him.

We spent the whole day hunting up this Balzer. On the way back to the Gilsey House, we called at the New York Institution for Improved Instruction, and saw Mr. Gruver, the Principal. At the last meeting of the National Educational Association I was appointed President and Mr. Gruver Secretary of Department XVI, and so wanted to have the opportunity of a talk with him over the programme for next year. He came on to the Gilsey House and took dinner with Mr. Booth and myself, and after dinner we went to the theater to see FLORODORA . I left Mr. Booth and Mr. Gruver there, and went to Jersey City, where I took the mid-night train for Washington, arriving here Thursday morning, Nov. 21.

Thursday and Friday I was feeling quite upset — bad head ache and so forth, and on Friday evening, Nov. 22, 1901, I sailed for Norfolk, Va., with Mr. McCurdy. Spent Saturday and at the Monticello Hotel, reading novels, rainy and disagreeable day. Late in the evening received a visit from Mr. Thompson — the red haired reporter that used to come and see me in Washington. He is now the editor and proprieter of a Norfolk, Newspaper, “The Dispatch”. He stayed with us until about 2 A.M. He told us rather of a curious story of an attempt to see Langley's flying machine fly.

He was ordered by the Washington Post to go down to Quantico, where Prof. Langley's new house boat was reported to have gone. The editors had information that an experiment 483 was to be made there with a large flying machine with a man on board, and the Washington Post wanted to be the first to have an account of the trial. They knew that it was no use asking Prof. Langley's permission, so they sent Mr. Thompson down to watch proceedings. He took rooms at a little hotel near there, as a sporting man anxious to fish, and engaged a boat by the day, dressed himself up in taupaulins with a false beard , and spent his time fishing in the neighborhood of the houseboat. The houseboat was in charge of a soldier, who would allow no one on board, and who seemed to be very suspicious of the fisherman. The Washington Post kept Mr. Thompson there for more than ten days, but Langley did not materialize, and he returned to Washington without any news.

On Sunday, Nov. 24, 1901, Mr. McCurdy and I took a long walk of some miles, and then caught an electric car for Sewell's Point, where there is a fine beach, and plenty of fresh air. I have my eye on the place for another excursion. We took the steamboat back to Washington Sunday evening, and reached here this morning, Monday, Nov. 25, 1901 — Mabel's birthday and out engagement day.

I find a letter here waiting for me from George McCurdy, dated Beinn Bhreagh, Nov. 19, 1901, reporting progress in the Laboratory, so I will append the letter to this dictation, see page 484

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COPY OF LETTER FROM GEORGE MCCURDY.

“Beinn Bhreagh, Victoria Co., Cape Breton, N. S., Nov.19, 1901 My dear Mr. Bell: —

None of the sheep have come in since Nov. 14. Have reduced the weight of young ones about on an average 3 pounds. One of the sheep had her lamb in May and would not come in anyway for some days yet.

At the Laboratory Mr. Watson and Mr. Ferguson's son are at work on the cells. Mr. Ferguson finished that light kite that he was at work on when you left and the dimensions now are 1 meter long and 1 m. in each of the sides of the triangle.

He begins tomorrow on the wire interior kite with oak rims. Kite to be shaped like Santos Dumont's balloon at either end, so as to enable us to streach the longitudinal wires. Diameter of kite 150 cm., length from end to end 400 cm. Number of cells 25cm × 12.5 (same size as the cells they are making now about 25.0 250 . Weight of wood in framework 4.25kgs. Weight of wire about 1.45875 kgs. weight of cloth 3.52kgs. Weight of extra material used to secure wire and wood about 1.14625. Making the flying weight of the kite about 400 grams. This is a pretty heavy kite but the greater the diameter of the kite the less becomes the flying weight. We cannot build a large one at first because we do not know how it will work, but if it does work I find by calculation that a kite of only 200 cm. by 500 cm. will have a flying weight of less than 375 grams per square meter.

This afternoon I put the telephones on the private line which have not been working all summer in order. They work now just as well as the other telephones.

Susie left yesterday and I am all alone now, but I can find lots to do so I have no chance to think about other peoples absence.

However I hope to see you all in about a month.

Yours sincerely, (Signed) David George McCurdy."

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1901, Nov. 29 Friday At 1331 Conn. Ave.

(Copied from Home Notes, 1901, Nov. 2, pp. 22,24,26,28).

1 METER CELLED COMPOUND KITE OF UNIT CELL 25cm.

Length of KITE No. of tiers of cells No. of cells. WEIGHT kgs. SURFACE sq.m. Weight available for strengthening frm.w'k. Load at 400 gms. per sq.m. 1 meter 4 40 1.3 3.75 166.6 gms. 1.5 kgms. 2 meters 8 80 2.6 7.50 333.3 gms. 3.0 kgms. 3 meters 12 120 3.9 11.25 499.9 gms 4.5 kgms. 4 meters 16 160 5.3 15.00 666.6 gms 6.0 kgms

2 METER CELLED KITE (composed of 25 cm. cells.)

Length of KITE No. of layers of cells No. of unit cells WEIGHT in KGMS. SURFACE IN SQ.M. Wt. Available for strengthening fm.w'k, kgms. Load at 400 gms. per Sq.m. 25 cm. 1 36 1.999 3.375 0.150 1.35 kgs. 1 meter. 4 144 4.799 13.5 0.6 kgms 5.4 kgs. 2 m. 8 288 9.599 27.0 1.2 " 10.8 kgs. 4 m. 16 576 19.199 54.0 2.4 " 21.6 kgs. 6 m. 24 864 28.799 81.0 3.6 " 64.8 kgs. 8 m. 32 1152 38.399 108.0 4.8 " 129.6 kgs. 486

3 METER CELLED KITE (composed of 25 cm. cells).

LENGTH of KITE No. of layers of cells No. of unit cells WEIGHT in KGMS. SURFACE in sq.m. WT. available for strengthening framework in Kgms LOAD at 400 gms. per sq.m. in

Kgms 25 cm. 1 78 2.6 7.3125 0.325 Kgms 2.925 Kgms 1 m. 4 312 10.4 29.25 1.300 Kgms 11.700 Kgms 3 m. 12 936 31.2 87.75 3.900 " 35.100 " 6 m. 24 1872 62.4 175.5 7.800 " 70.200 " 9 m. 36 2808 93.6 263.25 11.700 " 105.300 " 12 m. 48 3744 124.8 351.0 15.600 " 160.400 "

4 METER CELLED KITE (Composed of 25 cm. cells)

LENGTH of KITE No. of layers of cells no. of 25 cm. cells WEIGHT in kgms. SURFACE in Sq.m. Wt. Available for strengthening f'mw'k. LOAD at 400 gms. per sq.m. 25 cm. 1 136 4.533 12.75 0.576 Kgms 5.100 Kgms 1 m. 4 544 18.132 51.00 2.268 Kgms 20.400 Kgms 4 m. 16 2176 72.528 204.00 9.072 " 81.6 " 8 m. 32 4352 145.056 408.00 18.144 " 163.2 " 12 m. 48 6528 217.584 612.00 21.216 " 244.8 " 16 m. 64 8704 290.112 816.00 36.288 " 326.4 " 487

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HEXAGONAL KITE

LENGTH of KITE No. of layers of cells No. of Unit cells WEIGHT in kgms. SURFACE in sq.m. Wt. available for strengthening f'mw'k. LOAD at 400 gms. per sq.m. 25 1 216 7.2 20.25 0.900 Kgms 8.100 Kgms 1 meter 4 864 28.8 81.00 3.600 Kgms 32.400 Kgms 4 16 3456 115.2 324.00 14.400 " 129.600 " 8 meters 32 6912 230.4 648.00 28.800 " 259.200 " 12 48 10368 345.6 972.00 43.200 " 388.800 " 16 meters 64 13824 460.8 1296.00 57.600 " 518.400 " 488

1901, Dec. 4 Wednesday At 1331 Conn. Ave.

WIRELESS TELEPHONY

(A) & (B) two wires with slight gap between

(C) Uranium, Polonium, Radium or Actinium

(D) Pole ordinarily used in wireless telegraphy

(E) Telephone.

1902. Jan 7 — Tuesday

The above drawing was copied by me from a pencil drawing made by Mr. Bell to illustrate some idea — 1901 Dec 4

Jean Safford Secretary

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WIRELESS TELEPHONY. Transmitter.

1902. Jan 7

This drawing was copied by me from a pencil drawing made by Mr. Bell 1901, Dec 4

Jean Safford Secretary

490

THOUGHTS.

New Use for Wireless Telegraphy

To establish automatic meteorological stations.

1902. Jan 7.

This note was written by me from a shorthand note taken when Bell Bell was talking 1901, Dec. 14

Jean Safford Secretary

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1901, December 10 Tuesday Copied at 1331 Conn. Ave.

“Beinn Bhreagh, Victoria Co., N. S., Nov. 26, 1901. My dear Mr. Bell: —

We are getting on all right here at Beinn Bhreagh. Mr. Watson and John Ferguson have finished 16 of those kites that they were making.

Mr. Ferguson has finished all the rims and we start putting it together tomorrow. He has been just 6 days making them. I do not think that we will finish the kite by Saturday but we will do our best. The kites of different material that you wanted made have not been put together yet but all the sticks have been cut out. We tried to fly the light kite fastened together by glueing and pegging but it flew like a log and fell like a log breaking about 3 or 4 cells. There was quite a little wind blowing but it would not fly even when I ran with it. We then tied a stick to the keel and flew it from a point 25cm in front of the first cell. Kite flew steadily but fell.

We started to fly the Santos-Dumont kite today for the purpose of photographing the kite when the cell was moved backward, one cell's width at a time. It was not blowing very hard so we put it up using the red cord that you told me to use. The cord broke before the kite was up a minute and fell very gently, bow first.

But strange to say the kite went right around flying with the wind bow first. It however struck the telephone wire about the middle of the kite and broke in two pieces. It will take Mr. Ferguson two days to mend it.

We tested the red cord afterwards and found that it was all right excepting where it parted.

There are only 6 sheep left now. Weight of them all going down rapidly.

If you want us to stop work on the 30th we will do so, but if not let us know before that time.

Yours truly, (Signed) David George McCurdy.”

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1901, December 11 Wednesday Copied at 1331 Conn. Ave

“Beinn Bhreagh, Victoria Co., N.S. November 26, 1901 My dear Mr. Bell: —

All the work that has been done at the Laboratory is as follows: —

The day that you left (Saturday) the men cleared up both houses. On Monday Mr. Watson and John Ferguson went to work at the kites and at that they have been working ever since. I took a photograph of all the kites that they have finished today in number seventeen. On Monday and Tuesday Mr. Angus Ferguson finished the light kite which was glued and pegged together. I send you two photographs of it. Since then he has been making the framework put together until tomorrow. Mr. Ferguson also got out the sticks of different material for the kites that you spoke of just before you left.

You do not say anything about keeping the Laboratory open after November 30th, so I will stop work tomorrow night until further orders from you.

I am sorry that we will have to drop the wire interior kite before it is put together, but perhaps Mr. Ferguson can finish it himself. I will be here for a week, anyway, and perhaps for all winter but I am not sure, so for that reason if the kite is to be finished I should like to have been here at the time to see that everything was all right, so for that reason if the kite is to be finished I should like to have been here at the time to see that everything was all right. So far we have got just what my calculations gave me and I hoped to finish them in the same way.

I sent to Toronto for 1,000 meters of wire and it should have come last night.

Yesterday was Thanksgiving and so no work was done. Mr. Ferguson is putting the kites together (of different material) today as our oak plank has not arrived at B.B. yet out of which another longitudinal stick for the big kite has to be made.

I spoke to him about making the 100 kites and he said that he would figure it up tonight but he thought it would cost about $300 work. He will have to use the laboratory if he undertakes it and you will supply the material.

I have weighed linen and found that 1 square meter weighs only 100 grams, whereas 1 square meter of cotton weighs 150 grams. The linen seems to be as good as the cotton but we have not tried it yet on any kite.

By the way we never made the celluloid kite overlaping the supporting surfaces with back edges loose, but will do so if we continue the work at the Lab.

Yours sincerely (Signed) David George McCurdy."

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Enclosed you will find a photograph of all the kites and parts of kites put together by Mr. Watson and Mr. John Ferguson up to Nov. 29 in the afternoon 17 were finished kites 6 inside cells, and 1 outside framework. At the end of yesterday they had covered and finished 19 kites and had 4 more half finished. You do not say anything in your letter about keeping these men so I told Mr. Ferguson to close the laboratory and not to do any more work there unless I received instructions from you to the contrary, as you wrote in the laboratory note book.

I have photographed all the work done in the laboratory since you left excepting the sticks that Mr. Ferguson got out to construct the kites of different material, and at which he has been at work for two days: — viz. — Friday and Saturday. Thursday being a holiday. He has been just 7 days at the wire interior kite, making the rims and longitudinal sticks but we had to stop work on it owing to the fact that Mr. Ferguson's order for oak was never sent and consequently the oak never came. We are short 2 longitudinal sticks and the core so you see the work is at a stand still in that direction. In the meantime I am at the Point waiting to hear from you.

Mr. Ferguson told me yesterday that the cheapest that he could construct the 100 kites that you wanted made (under these circumstances you supply the material and the Laboratory for his use) was three hundred dollars ($300). I think that I told you that in my last letter.

The sheep are now all at the Point including lambs and all the new and old ones. Mr. McInnis gets 18 sheep at the Red Barn tomorrow.

In the last two days they fell on an average about 8 pounds. Five are yet unserved, 1005, 1027, 1030, 1032, and 1049, the last being an improved breed bought this fall.

What will you do about them? John says that you said to let any sheep that did not come in before the 30th go, so he has, but it seems a pity to let 1049 go since he cost so much in the first place and is such a beauty.

(Signed) David George McCurdy."

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THE WASHINGTON POST, WEDNESDAY, DECEMBER 11, 1901.

Mrs. Charles J. Bell entertained yesterday at one of the largest and finest teas of the season, the occasion being the debut of her second daughter, Miss Grace Bell. Mrs. Bell and the debutante received in the drawing room, the former wearing a French gown of coffee-colored crepe, with accessories of light blue, and the latter an exquisite creation of chiffon and insertions of cream lace, on a foundation of heavy white silk. The bouquet, chosen from dozens of roses, lilies, and violets, was of white orchids. Mrs. Hubbard, the mother of the hostess, also welcomed the large company.

In the large apartment joining the drawing-room, which was built as a ballroom and now serves as the living room of the family, Miss Helen Bell, the handsome young sister of yesterday's bud, served frappe, assisted by several of the large receiving party, which included Miss Poor, Miss Goldsborough, Miss Marie Barnes, Miss Mackay-Smith, Miss Townsend, Miss Grossmann, all this year's debutantes; Miss Ashton, Miss Deering, Miss Carola de Peyster, Miss Hildegard McKenna, Miss Zaidee Cobb, and Miss McCauley.

In the dining-room, which was exquisitely decorated in pink roses and lighted by pink-capped tapers. Mrs. Ralph Jenkins and Miss McLanahan did the honors of the richly appointed tea table.

PRESIDENT SENT HIS CHECK.

About $200 Realized from the Bazaar at the Newsboys' Home.

A “house warming” was given yesterday afternoon at the home of the Newsboys and Children's Aid Societies, Third and C streets northwest. The home, which is known as the George Maulsby Memorial Home, has been entirely renovated and painted recently, and everything is now clean and bright for the winter.

Visitors were shown through the building yesterday, and from 2 until 7 o'clock p. m. a bazaar was held. All sorts of fancy articles, such as dolls, lamp shades, table covers, &c., were offered for sale. There was a room in which flowers and candy were sold and tea was served in the old conservatory, which is now used as the children's dining-room.

President Roosevelt sent his check for $10 and Mrs. Roosevelt sent her card. These were placed in a small gold frame by one of the ladies and were offered for sale at $50. Capt. Miller presented the association with a beautiful rug for the bazaar.

The bazaar was conducted by the junior committee of the Newsboys and Children's Aid Society, of which Miss Laura Wolcott Jackson is the president, Miss Bainbridge Hoff secretary, and Mrs. Gaff treasurer.

The articles for sale were all donated by friends of the institution. Miss Bell, Miss Siebert, Miss McLanahan, and Miss Hay had charge of the flower and candy room. Mrs. Morris

Murry presided at the tea table and she was assisted by Mrs. John Poor and Mrs. Simpkins. Miss Bainbridge Hoff, Miss Bikley, and Mrs. Charles Ray looked after the fancy table.

The proceeds of the day were in the neighborhood of $200.

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see p. 500

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1901, Dec. 14 Saturday At 1331 Conn. Ave.

SUGGESTED FORM OF NOTIFICATION NATIONAL GEOGRAPHIC SOCIETY.

Washington, D.C., Dec. 14, 1901. Hon. W. Murray Crane, Governor of Massachusetts, Boston, Mass. My dear Sir: —

I take pleasure in informing you that you have been elected a member of the National Geographic Society on the nomination of the Hon. H. B. F. Macfarland, Commissioner of the District of Columbia. The nomination was favorably reported by the Committee on Admissions, and unanimously approved by the Board of Managers. I trust you will permit us to welcome you into the Society.

The Secretary will forward to you under separate cover full information concerning the work and publications of the Society; and, on notification of your acceptance, we shall be pleased to send you a certificate of membership.

Very sincerely yours, President National Geographic Society.

1901, Dec. 16 Monday At 1331 Conn. Ave.

LIST OF GENTLEMEN INVITED FOR MR. BELL FOR WEDNESDAY EVENING DECEMBER 18, 1901.

Mr. C. J. Bell,

Rev. Teunis Hamlin,

Mr. R. K. Tyler,

Mr. Bernard Green,

Senator Spooner,

Hon. Carroll D. Wright,

Major Powell,

WJ McGee,

Prof. S. P. Langley,

Hon. David Jayne Hill,

Representative Hitt,

Mr. George Kennan,

Surgeon Gen. Sternburg,

Prof. Gilbert,

Senator Cockrell,

Mr. Willis Moore,

Mr. Chas. D. Walcott,

Mr. F. A. Lucas

Mr. A. C. True,

Mr. Marcus Baker

Dr. Hart Merriam,

Mr. Coville,

Mr. Heron,

Mr. Stanley Brown,

Prof. Simon Newcomb,

Mr. Bailey Willis,

Mr. Archibald Hopkins,

Representative Cannon

Mr. Warner

Mr. A. W. M cCurdy

Mr. George McCudry

W. Gilbert M.

1901, Dec. 17 Tuesday At 1331 Conn. Ave

Regarding the flying of the kite shown on page 495, Mr. George McCurdy says: —

We fastened the string to the front of the first cell by binding it round the kite, and fastened it to the bamboo pole. There was quite a little wind blowing, but the kite would not rise. We then went down to the Laboratory and got a pine stick half a centimeter cross section, and about 2 metres long. Fastened this stick to one of the corner longitudinal sticks by strings bound all the way round the kite — at the front, middle and back — leaving a metre of the stick protruding beyond the kite.

We then fastened a string from the end of the stick to the two remaining front corners. This string was to strengthen the stick.

We then fastened the flying string about 25cm. from the front cell to this protruding stick. Mr. Ferguson took the kite up to the fence above the road, so that we would be sure to get the best wind. I then an with the kite against the wind with quite a long string. The kite rose steadily not very far, and fell immediately after I stopped running smashing three or four cells at the stern of the kite.

The flying of this kite was also described in my letter on p. 491.

David George McCurdy Weight of kite, 1147 gms. Surface 3.75 Sq. m. Flying weight 303.1+ gms. See Lab. Notes, p. 172, 1901, Nov. 19, p. 174, 1901, Nov. 23

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In regard to the Bird Kite shown in the photograph on p. 476, which was broken on November 26: Mr. George McCurdy says: —

We flew this kite from a bridle attached to the front of the first cell. Wanting to photograph it, so as we could see the angle that the string made with the kite, we used the red cord, which has been lying in the laboratory half the summer, fastening this between the bridle and the regular flying cord. The first wing was fastened over the first cell, and the second wing over the second cell. One end of the flying cord was fastened to a lumber framework lying in the field. I had the camera all ready and telling Mr. Ferguson to let go the kite I ran down towards the road so as to get a photograph from the side of the kite. Upon coming to a stand still I saw that the kite had broken away from the cord and was flying gently towards the earth bow from the wind. It struck the telephone wire just back of the second cell, turned a summer-salt over the wire broke in two, and falling to the ground on the other side upon the wings, broke two or three of the cells.

David George McCurdy

See Lab. Notes, 1901, Nov. 26, p. 175

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1901, December 19 Thursday At 1331 Conn. Ave.

I have just been looking over my dictated notes. Hardly anything has appeared since I returned from Baddeck. Notes appear under the following dates: —

VOLUMES 1, 2 and 3

DATES 1901 July August October November December 19 — — — — 20 27 2 — — — S 28 — — — 22 — 4 — 4 23 30 5 — — 24 31 S — — 25 7 — — — SEPTEMBER — — — — — S — — — S 2 — — 10 29 — — — 11 30 4 12 — — 31 5 S — — 6 — — 14 August 7 — — S 1 S 16 — 16 2 9 17 — 17 3 10 — — — S 11 — 19 19 5 12 20 — — 13 — 21 7 14 22 22 8 S — — 9 16 — S 10 17 25 25 S 18 26 — 12 — 27 — 13 20 28 — 14 21 29 29 15 S — — 16 23 — 17 — S 25 19 26 — — 21 28 — S 23 30 24 S 503

It is obvious that we cannot hope to keep accurate notes unless we make a practice of making a note every day however short. We must try to dictate at least one page a day. The best way to accemplish this will be to make the dictation before doing anything else. If we try to answer letters first THERE WILL BE NO DICTATED NOTE THAT DAY!

Miss Safford: says: — “You have all your letters up to date, the first time since I have been here.”

I don't think that one dictated page will interfere with letters. The trouble is that if I once commence dictating it is difficult to stop. All the time is consumed, and my letters, &c., stop.

I think it would be a good plan to make diary notes and to dictate a description of items that have been read in the newspapers, magazines or books. Some of these items might be suitable for the National Geographic Magazine. All of them would form suitable topics for conversation. If I dictate an account of something that has interested me, I make it my OWN and will have no difficulty afterwards in recalling it in conversation.

Last Saturday, Dec. 14 left in the evening for Norfolk, Va., with Bert, breakfasted Sunday morning at Monticello Hotel, (Dec. 15), went on to Virginia Beach from Norfolk by the 11.30 train, spent Sunday and Monday (Dec. 15–16) at Princess Anne Hotel. Monday, Dec. 16 drove from Virginia Beach up to 504 Cape Henry in hopes of finding a suitable station for flying giant kites. The shore between Virginia Beach and Cape Henry is desolate and practically uninhabited, but could find no place suitable for my purpose because telephone wires on one hand and tall pine trees on the other would interfere with safe landing. Decided therefore not to purchase a lot there.

Left Virginia Beach Monday afternoon December 16 for Norfolk, took steamer the same evening and arrived in Washington Tuesday December 17, early in the morning.

Last night, Wednesday December 18, had my first gentlemen's party. For list of persons invited see p. 499. There were present during the evening Messrs. Tyler, Wright, McGee, Kennan, Sternberg, Moore, Lucas, True, Baker, Coville, Newcomb Willis, Warner, A. M. McCurdy, George McCurdy, Gilbert H. Grosvenor, and A. G. B. Total seventeen gentlemen.

Mr. Murray with a boy operated his lantern in the dining room, and Mr. Bailey Willis showed some beautiful slides taken in the Rocky Mountains.

Mr. George Kennan described his arrest on leaving Russia by a German official. A show of hands was called to find out how many of the gentlemen present had at some period of their lives been arrested. Eleven out of fifteen present at the time confessed to arrest — some of them several — so that there had been more arrests than gentlemen present. We had very interesting reminisences of the incidents.

Gen. Sternberg gave us the most recent information concerning yellow fever and mosquitos. The Pasteur filter, he 505 he said, has generally been supposed to filter out germs of all sorts, but it fails to remove from blood the germ of yellow fever, and it was now supposed that the germ of yellow fever is too small to be visible even with a microscope. I am not quite sure of this experiment; but, as I understand it infected blood from a yellow fever patient was passed through a Pasteur filter, and the colorless serum obtained was used to infect mosquitos. After the lapse of twelve days these mosquitos were allowed to bite a non-immune person, and the person then had yellow fever. I may be wrong in this, but such is the impression I gathered.

A writer in Nature verifies a statement that occurs in Howard's book on mosquitoes, for he makes the announcement that a box (probably a transformer) connected with an electric light attracted myriads of male mosquitoes. The box emitted a sound of about the same pitch as that made by the female mosquito, and the moment the electric light was turned on the male mosquitoes in the vicinity immediately headed — not for the light — but for the box.

THE DATE OF STONEHENGE, has long been a problem. The temple existed long before the Roman invasion of Britain, and, from quotations contained in classical writers, it has been supposed that, like the sun worshipers, the ancient Britons observed, with religious ceremonies the rising of the sun, especially at the time of the summer solstice.

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Examination of the ruins of Stonehenge favored this supposition. The temple was evidently in circular form. It is surrounded by a circular bank of earth of great dimensions, excepting at one point, where an avenue, or road led into the enclosure, with high banks of earth on either side, which can still be traced in a straight line for fifteen or sixteen hundred feet. These banks connect with the rim of the circular enclosure. It is supposed that the central temple was roofed over, and, at the time of sun-rise, the interior darkness would be suddenly broken by a ray of sun-light falling upon the central altar.

In confirmation of this idea it has been noted that the avenue leading to the ruins extends in the general direction of the rising sun, but xx from the central part of the ruins, the sun no longer rises exactly in the center of the avenue. Sir Norman Lockyer has recently undertaken an examination of the ruins, and made calculations to ascertain at what period of time in the past history of the world the sun would rise at the time of the summer solstice exactly in the line of the avenue, and from these calculations it appears that Stonehenge was probably erected somewhere about 1680 B. C., with a probable error of 200 years p lu s or m in us.

(Nature, Nov. 21, 1901, Vol. 65 pp. 55—57)

There is a proposition noted in the newspapers to cool the St. Louis Exposition by dragging down air from a height of about 1,000 feet, and distributing it over the surface. I presume a sort of Eiffel Tower arrangement to support a pipe, 507 so that the cool air above may be dragged down by rotating fans, or other arrangements.

Becquerell announces to the French Academy that the emanations, or radiations from r adi um affect white phosphorus causing it to turn into the red variety. He also announces that grains of various sorts exposed for some days to the radiations emitted by radium, fail to germinate.

The wire saw has been adapted to quarrying. Great blocks of stone or slate can be sawn out from a cliff without the use of explosives. (Nature Nov. 28, Vol. 65, p. 84).

“Speaking of Mahomed, Sir Lauder Brunton describes his visions, trembling fits and convulsions, and said it was curious to speculate how different might have been the course of the world's history if the prophet had been thoroughly dosed with bromide of pottasium”. (Nature, Vol. 65, p. 86).

The National Geographic Magazine is referred to in Nature October 31, Vol. 64, p. 658.

The German Kaiser has been in the habit of answering kindly, letters from school children. The result is that thousands and thousands of letters have been sent to him by school children, until the whole matter has been a nuisance, 508 and the school teachers in Germany are now instructed to punish the children who write.

Books wanted: — The Crisis by Winston Churchill, Knowledge Diary and Scientific Hand Book , for 1902, advertised in Nature November 28, opposite p. 84.

Life by the Sea-shore , Marion Newbigin, London, Swan-Sonenschei & Co., 1901, reviewed in Nature Oct. 24, p. 621.

Dragons of the Air : An account of extinct flying reptiles. By H. G. Seeley, London, Methuen & Co., 1901, reviewed in Nature, Oct. 31, p. 645.

Willis-Moore tells a story on himself when he visited the Yellowstone, and began to eat his dinner very hurriedly at the Inn. The landlord who was somewhat of a wag noticed his hurried eating, and tapping him on the shoulder, whispered i in his ear “Please leave the plates, I need 'em”.

The newspapers, having reported that Marconi had been obliged to stop his experiments in Newfoundland on account of interference with a telegraphic monopoly held by the

Anglo-American Cable Co., — and that he was about to leave for cape Breton Island in search of a suitable station for wireless telegraphy to Europe — I sent him yesterday the following telegram: —

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“Washington, D.C., Dec. 18, 1901. Mr. Marconi, St. Johns, Newfoundland.

Congratulations and best wishes. If you can make use of my estate in Cape Breton, near Baddeck, as a temporary station, you are welcome to it and my Manager, Mr. McInnis will be glad to take care of you and your party and do everything possible to facilitate your experiments. Telegraph reply Washington,

Graham Bell.”

I have not yet received any reply, but Marconi evidently received my telegram because the New York Herald of this morning reproduces it, with comments. I asked the Herald representative by telephone where they got the message, and he replied that it had been sent to them by their Newfoundland correspondent.

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1901, Dec. 27 Friday At 1331 Conn. Ave.

OCEAN POWER.

The feeble and variable force of the wind is already used by tens of thousands of ships, pumps, &c. Why not employ the far more powerful, regular and tractable force of the wave? And the wave is more nearly continuous. It springs up with the wind, and continues long after the wind subsides. The wave is wind power stored up.

Fifty square miles of ocean surface would yield more power than now in use in all the world. A wave is a waterfall.

All ships could be propelled by wave power, utilized by an invention “absurdly simple.” All factories, cars and other vehicles within 100 miles of the seashore could be run, and all lighting, heating and plowing done by wave power converted into compressed air or electricity at 1–10 to ½ the cost of steam or animal power.

The sails or furnaces of a large ship require a crew of 20 or more men; the motors of the largest ship propelled by wave power would need but one.

The use of ocean power would soon double the size of many cities and towns on or near the seashore.

There are places where land along the seashore can be bought for almost nothing By using ocean power there for factories, etc., the land might be resold at high prices.

Any progressive man wishing to aid in bringing ocean power into use for profit, or for the pleasure of seeing the great changes it would make, or for the advantages it would give his city, state or nation over others not maritime, or with less coast, should give us opportunity to reply to any objection, and to show models.

S. N. STEWART. 168 JEFFERSON AVE., BROOKLYN, N. Y.

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1902, January 6 Monday At 1331 Conn. Ave.

GOOD RESOLUTION FOR NEW YEAR

Whereas: There have been no dictated notes for a long time

RESOLVED: — That we shall have at least one dictation every day, occupying at least one page:—

AND FURTHER RESOLVED: — That the dictation will come first thing in the morning, before letters and other business have the opportunity of monopolizing my time: —

IN PURSUANCE OF THE ABOVE RESOLUTIONS let me begin with describing the idea that Miss Safford tried to save — I mean ideas, for I notice more than one noted on pp. 488, 489 and 490, under date 1901, December 4 — more than a month ago.

WIRELESS TELEPHONY.

The impulses generated by the induction coil, condenser, or other apparatus used to produce the spark at a wireless telegraph station, consist of very sudden and powerful shocks. It would be no more possible to transmit speech with such impulses than to do so with an intermittent voltaic current — chopped up and all of the same force.

There must be a disturbance of the medium, corresponding in its variations of intensity to the variations in the density of air, when a sound is uttered, or transmitted. There must be electrical UNDULATIONS — not INTERMITTENCES. The electrical potential, at any place in the medium, should vary 512 in a manner analogous to the variations of density in the aerial medium.

Represent graphically by a curve the changes of density occuring at some place in the air, while a sound is being transmitted, then, what we want to do in order to transmit that sound through space by means of radiated electrical impulses traversing the medium employed (the ether of space — the luminiferous medium — the electrical medium, or whatever it may be called) — what we want to do is to cause electrical changes of such a character that, if they were represented graphically by means of a curve, the curve should be identical in shape to the curve representing the changes of air pressure or density: For example, let electrical potential correspond to density of air, than, we want to make the electrical potential vary as the density of the air varies when a particular sound is transmitted — When the density of the air is increased, the electrical potential should be increased — when it is diminished the electrical potential should be diminished — and increased or diminished in like proportion.

If an increase of an electrical potential of a certain amount corresponds to an increase in the density of the air of a certain amount, then, if that change of density is doubled, the variation of potential should be doubled, &c. We should aim to make a complete correspondence between the VARIATIONS of some one element of the electrical effect (say potential) and the variations of air pressure or density, 513 characteristic of a given sound.

The electrical agitation produced when a spark is perceived, is not of the character desired, consisting as it does of a series of rapid, disruptive discharges.

The frequency of discharge, however, is so great (Probably hundreds of thousands in a second of time) that perhaps it might be possible to produce electrical variations corresponding to the slower variations characteristic of sound, (hundreds in a second) Just as it is possible to interrupt an undulatory current of electricity, without materially interfering with the transmission of speech, although it is not possible to transmit speech by a series of impulses of the same strength — or what is usually termed an “intermittent” current”. Indeed, the discharge of a leyden jar is of this kind, and does produce a sound — a noise or musical effect, not one having the definitness of a spoken sound. The discharge consists of a series of sparks, succeeding one another with the frequency of a sound, but each visible spark is accompanied by an inconceivably rapid series of changes of electrical potential in the jar — the frequency running up into the hundreds of thousands a second.

The Dolbear Telephone consisting of two metallic diaphrams, very close together but not touching, forming the two plates of a condenser, seem s to me to form an arrangement by means of which disturbances of the medium, transmitting electrical effects, can be produced, corresponding to the disturbances in the air produced when the sound is uttered.

514 Transmitter for wireless Telephony

let ab be the vertical wire, or antenna of a transmitting station metallically connected to one of the plates of a condenser arranged as a telephone, and consisting of two metallic diaphrams very close together (the distance apart is exaggerated in the drawing above), insulated from one another, and so arranged that one (at least) can be set in vibration by the voice of a speaker. The other plate is metallically connected to one of the terminals of a source of E.M.F. (say a voltaic battery). The other terminal of E.M.F. is connected with the 515 ground.

NOTE. Th e E.M.F. might be a charged Leyden Jar, which probably would give a better effect than a voltaic battery.

The plate d is charged electrically by proximity to the charged plate c , and its electrical charge is communicated to the Antenna ab . Now, when a person speaks in the neighborhood of the charged plate c , it vibrates(alternately approaching towards d and receding from it.) As it approaches nearer to d the electrical charge in d is increased; as it recedes from d the electrical charge of the latter is diminished. These effects being propagated to the Antenna AB , we have in that Antenna a variation of electrical potential corresponding to the vibration of the diaphram C . — which variation should theoretically be communicated to the etheric medium surrounding it, and be propagated through that medium with the velocity of light.

Supposing such an effect to be in reality produced, the receiving apparatus employed in wireless telegraphy would be quite inadequate to enable us to perceive an effect. The particles of a“coherer”, cohere when an electrical impulse reaches the station, and then the apparatus is insensitive to any further effect until the particles have been made to “de-cohere”. This is accomplished by striking the apparatus a blow, so as to shake up the particles, and cause them to fall apart. Such an apparatus must surely prove to be an unreliable receiver for any sort of effect, and surely it would prove incompetent to respond to the delicate changes of electrical potential in the etheric medium corresponding to the vibrations 516 of the diaphram C .

It seems to me to be necessary that the space occupied by the sensitive parts of the coherer (the gaps between the particles) should be CONTINUOUSLY sensitive.

Let the two wires g , h , be enclosed in a tube as in the usual form of coherer, with their ends almost in contact with one another. Then, in place of the metallic or conducting particles usually employed, place in the tube some radio-active material (one of the salts of uranium, some polonium, radium, or actinum, or other radio-active material); then the effect of the presence of such radio-active material will be to render the space between the wires g, h, CONDUCTING so that the circuit will be completed between the two poles of the 517 battery, or other E.M.F. employed, and a current will traverse the telephone.

The gap between g , h , will only be slightly conductive, so that the current will be slight, and continuous, so that no sound would be produced from the telephone. But, if an electrical impulse reaches the receiving antenna ef the conductivity of the gap between g , h , should be increased or diminished according to the electrical potential. We should have in the space between g , h , a SENSITIVE GAP, the conductivity of which should vary with the intensity of the impulses received by the antenna. If these variations correspond to the variations of a sound, the telephone should respond, and audibly repeat the utterances of the person at the transmitting station

THOUGHT Would not the transmitter also do as a receiver, and the instruments at either end be identical.

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1902, January 7 Tuesday At 1331 Conn. Ave.

?E WASHINGTON POST, TUESDAY, JANUARY 7, 1902.

The Secretary of Agriculture and Miss Wilson entertained at dinner last evening the following guests: Senator and Mrs. Hanna. Senator Clark, of Montana; Mr. and Mrs. J. B. Henderson, Mr. and Mrs. Merriam. Mr. and Mrs. Alexander Graham Bell, Surgeon General and Mrs. Sternberg, Mrs. Fabyan, of Chicago; Mr. Jasper Wilson, Miss. Mattingly, and Prof. Willis L. Moore.

The following gentlemen have been invited to Mr. Bell's Wednesday evening, 1902, January 8: —

XO. P. Austin 1620 Mass. Ave.

Present—Frank Baker 1728 Columbia Road

—L. A. Bauer 1925 I Street

XG. F. Baker Geological Survey

XMarcus Benjamin 1710 N Street

XFrank H. Bigelow 1625 Mass. Ave

—H. C. Bolton 1519 K Street

—Dr. Swann Burnett 916 Farragut Square

XArthur Keith Geological Survey

XAlbery G. Robinson The Arlington

—Wm. H. Dall 1119 12th Street

—David T. Day Geological Survey

XS. F. Emmons 1721 H Street

—Elmer Gates Chevy Chas 3

—F. W. Hodge Smithsonian Inst.

XF. H. Wines 1446 Staughton Street.

8

24 persons present.

519

Au toma tic Me teorologi cal S ta tion

The note made by Miss Safford on p. 490, viz: —

"THOUGHT: — New use for wireless telegraphy — to establish automatic meteor o logical stations" dated 1901, December 4, was to remind me to make a dictation of what I had suggested to Prof. Willis Moore the evening before after dinner. Mr. and Mrs. Willis Moore dined here on Tuesday, December 3. In the course of conversation during the evening I suggested that the Weather Bureau might find a great use for wireless telegraphy by establishing automatic meteor o logical stations in isolated places, difficult of access — for example the top of a mountain — and receive daily reports from these places automatically by means of wireless telegraphy. There would be little difficulty in arranging an automatic meteor o logical station where records of wind pressure, temperature, &c., &c., could be made and reported automatically.

Such stations could be located here and there wherever desired, even in uninhabited regions — the Arctics for example — and picked up occasionally. Such records, however would be of no value in forecasting because they would come too late — months after date, perhaps — whereas, to be of use in forecasting the records must be available and in hand about the time they are made. If such mete o rological stations were connected by wire with any civilized place, it would not be difficult to invent an arrangement by which the stations could be tapped when desired, and the records transmitted automatically by telegraph.

An extended telegraphic system for this purpose alone, would hardly pay; but, why should not the same end be accomplished by wireless telegraphy, where the distances are not great. A station located on the top of a high mountain 520 might be of great value if the barometric pressure, temperature, &c., could be ascertained every day, at the time when simultaneous observations are being made all over the United States.

There surely would be little difficulty in establishing communication by wireless telegraphy between a station on a high mountain and a point in the plain a few miles away.

Given an observer on the mountain, and he certainly could transmit the elements of the weather by wireless telegraphy to the station below. Why not a mechanical transmitter, operated by clock work, or other motive power — wou l n d up once a week, once a month, once a year — by a visitor to the station — or automatically wound up by a wind mill whenever the wind should blow.

If connected by wire with the plain below, the apparatus could be wound up by telegraphy. There would be absolutely no difficulty in making a winding up arrangement operated by electricity, in such a case.

I have given my attention to this subject before. The idea of having automatic stations connected by telegraph wires is old with me, and I worked out some of the details years ago, which might perhaps be applicable to the new idea of using wireless telegraphy in tapping the records.

How can you transmit a record of temperature, barometric pressure, or wind direction, automatically by telegraph?

Very simply — by three dots. Each record can be transmitted by three dots. The plan I worked out years ago was based upon this idea. Suppose we have a non-metallic cylinder that can be rotated about a vertical axis, and we place round 521 this cylinder a metal ring top and bottom with a metallic spiral connecting the two making one complete turn around the cylinder, the whole connected metallically with the axis of the cylinder, which should be of conducting material, a spring pressed against the axis, with light friction connecting the arrangement with a voltaic battery or other E.M.F.

In above diagram a , and c , are the metallic rings, and b the metallic spiral connecting them, and d the contact spring against the axis. I have attempted on the next page to give an idea of the electrical connection, with the distant station, but my electrical connections are a little mixed up; however, it doesn't matter, as it is obvious that the electro magnet shown can be operated from the distant station through the telegraph wire. As it is not my object to show the exact means of connection with the electro magnet, I will let 522 the diagram stand, and will simply say, that when we want to tap the record, an electrical impulse is send from the distant station, the electro magnet then attracts its armature, this

Transmitting Station

removes the detent from the tooth t , and the weight w falls down, or rather slides down, to the bottom of the rod passing through it.

The weight carrie s d a rubbing contact r , shaped somewhat like an umbrella spring, which — normally rests very lightly — or does not touch at all, the surface of the cylinder — but, when the weight is released, the rubbing contact r makes contact alternately with a , b , and c , thus transmitting three electrical impulses to the distant station.

At the receiving station there is a similar arrangement, but, the cylinder has preferably a metallic surface, and is covered with a sheet of prepared paper, like that used in chemical telegraphs. The original impulse that operated the electro 523

Receiving Station

magnet at the transmitting station shown above, on p. 522 also operates a similar electro-magnet at the receiving station, at the same time, so that the weight w at the receiving station, is released at the same moment as that at the transmitting station p. 522.

When the three electrical impulses from the cylinder at the transmitting station, reach the receiving station, they are received as three blue dots on the paper wrapped round the cylinder (see dots a , b , c , on the cylinder unrolled above).

The position of the dot b in relation to a and c indicates the position of the cylinder at the transmitting station when the weight was dropped.

When another observation is taken at another time, the cylinder at the transmitting station — if operated by a metallic thermometer — may have been turned into some new position — in which case the position of the blue point b , relatively to a and c , would have been different.

Supposing observations to be taken every hour, and at each observation the paper cylinder at the receiving end is shifted one tick, so that the successive records received from the transmitting station appear side by side on the papery cylinder. 524 Then, the result of the day's observations, when the paper cylinder is taken off and unrolled, might appear somewhat as follows: —

In which b shows the fluctuation of temperature at the transmitting station.

If the weights at the two stations are synchronously dropped, the a line of dots will form a straight line on the receiving cylinder, and the c line of dots another straight line, parallel to the a line. Should, from any reason, the two instruments fail to act with the perfect synchronism, the a and c dots will be displaced showing the need for a correction at the point. But, the position of the b dots RELATIVELY to a and c will not be affected, and the correct temperature viz: — the correct position of the point b can be ascertained in a very simple manner, which allows us to reduce or magnify the SCALE of any record. Upon a triangular frame, like that shown on the next page, p. 525, have an adjustable arm. Place the frame over the faulty record containing the dots a ', b ' c ', so that the a and c dots come against the fixed sides of the triangle. Then adjust the arm against the b ' dot, as 525 shown, At that part of the frame where the a and c dots are at the proper distances apart (viz: — a “, and c “) ticks are marked on the frame. A dot b “ made at the point where the adjustable arm comes, will indicate the corrected position. for these By the mechanical construction of the instrument it is obvious that the dot b ” occupies the same position relatively to a “ and c “ that the dot b ' occupies relatively to a' and c '.

Lunch time and I must stop. Will simply add: A transmitting cylinder for temperature, another for pressure, another for wind direction, another for wind velocity, or any other elements that are desired. I need not enter into any description how these cylinders may be operated, as means are already well known. I would simply have a mechanical arrangement operated by clock work, that would switch the cylinders on to the line alternately, in the proper order.

While the above description is imperfect — especially in regard to the operation of the detents, enough has been said to give a general idea of the way in which the meteor o logical elements at a distant station may be ascertained by telegraph automatically. A.G.B.

AGB

526

1902, Jan. 8 Wednesday At 1331 Conn. Ave.

Yesterday, Tuesday January 7, attended meeting of Board of Directors of Washington Academy of Sciences at the Cosmos Club, 4.20 to 5.30 P. M. Attended Mabel's reception 5.30 to 6.30 P. M. Dined with Mr. Kauffmann 7.30 to 9 P. M., present Mr. Kauffman, Senator Proctor, Hon. John W. Foster, Mr. George Westinghouse, Mr. Kauffmann, Jr., E. M. Gallaudet, Mr. Noyes Hoyt of the Evening Star, Surgeon Gen. Sternberg, Gen. Wilson, ex-Senator Henderson, Commissioner MacFarland, Commissioner of the District, and several others whose names I forget. At 9.30 P. M. took Mabel and Daisy to the President's reception at the White House — a tremendous jam — Met a great many people I knew, but couldn't name one in ten. Wound up with supper at Willards, saw Dr. Ker and Ninie there.

Lost the whole of yesterday without attending to correspondence and important matters, can't afford any long dictations.

Yesterday started out to see whether Mr. Zable could act as intermediary between me and workmen, so as to have some apparatus made and experiments tried. Set him to work to make working drawings of the transmitter for wireless telephony shone on p. 519. If they are satisfactory to me he is to take them down to a workshop and have the apparatus made. I don't think it will pay for me to support a laboratory and a staff of men, it would fetter me too much, and yet, I don't feel happy without the means of experimenting. We have plenty of

Interrupted. AGB

527

Proposed experiment to ascertain whether sounds of different pitch travel at different rates .

I have often been interested in watching a man at a distance hammering a post into the ground. I could see when the blow was struck; but a perceptible time would elapse before the sound was apparent. It appears to me now that the sound heard was a double stroke, resembling the blow followed immediately by an echo of it. Theoretically two sounds should be produced by the blow — one emanating from the mallet, and the other from the post. These sounds would differ from one another in pitch or other characteristic. Could it be possible that one of these sounds traveled faster than the other and that this was the cause of the echo-like effect.

I am by no means convinced that sounds of different pitch travel with precisely the same velocity. The matter could very easily be settled by striking two sonorous bodies together I tried such an experiment in Baddeck. Instead of striking our big dinner bell with the tongue proper to it, I had the bell struck with a small hand bell. The big dinner bell gave forth a sound of low pitch, the small hand-bell a sound of high pitch, and, as the blow was common to both, the energy of impact was the same in both cases, and both sounds started at the same moment. I observed the effect from our lawn. Only one blow was heard, and the two pitches were clearly apparent. The distance, however was not sufficiently great to render the experiment conclusive.

Sound travels at the rate of 1100 feet per second. If there should be a difference of one foot per second (which would be a very considerable difference) we would require to go 528 several times 1100 feet away in order to perceive the difference with the ear. A mile (5280 ft) is only about five times this distance. We should have to go at least a mile or two miles to be sure of the effect. This means that the sounds produced must be of great intensity. They must be sounds that would be audible a mile or two away. The experiment is really very well worth trying.

A very powerful blow must be struck, and the two objects which are brought in contact should have very different pitches. The attempt to chop down a tree is heard at a great distance away. As I try to recall the sound of distant chopping, I fancy I can recollect the echo effect, like a double stroke instead of a single one . The axe and the tree would surely give forth different sounds.

Usually, however, the two objects brought in contact are not equally capable of producing loud sonorous effects. A drum stick, for example, is not as capable of sonorous vibration as the drum head. We should strike one sonorous body by means of another of different pitch, so that both sounds produced could be heard at a distance.

It would be worth while trying a single blow on a drum. As action and reaction are equal and opposite, the energy of impact is equal, and the drum strikes the drum stick as heavy a blow as the drum stick strikes the drum. Make one single tap on a drum, and see whether at a great distance away two taps are audible.

Can't afford any more time. A.G.B.

AGB

529

Sound for the blind—

I would like to put down a thought for elaboration on another occasion.

There has been a discussion in Nature concerning the cause of the change of pitch of certain sounds with distance — for example the hissing sound of escaping steam. Mr. F. M. West observes, Nature Dec. 12, p. 129 that while walking up and down the platform of a railway station the pitch of the sound caused by the steam escaping from an engine, rose as he retreated from it, and fe ll el as he drew near to it. Van Gulik also discusses the matter in Nature December 26, p. 174, and says: — “The pitch will not only rise by retreating from the engine, but also by bringing the ear nearer to the ground. The pitch is due to reflection of the sound from the platform itself, for when a large board is laid down on the ground between the engine and the observer, the pitch will be heard to rise when the board is raised”.

He believes the phenonemon to be caused by interferance between the direct and deflected sound waves — a sort of sound spectrum is formed. He examined the matter mathematically, and states that the facts agree with the theory.

“When the noise of a water fall of rustling trees is perpendicularly reflected by a wall, Baumgarten has observed the change of pitch in the vicinity of this wall. (Muller-Pouillet, ‘Lehrbuch der Physik’ Vol. I, p. 732.)”

Van Gulik says that his results are also applicable in this case, and states that in the neighborhood of a water fall he obtained experimental results perfectly agreeing with theory.

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THOUGHT : — Why should not the fact be applied for the benefit of the blind. A walking stick might be converted into a veritable sound lantern . Let there be a hissing escape of air from the point of the walking stick. It need not be loud, only so loud that the blind man can hear it. By moving his stick about he would speedily become conscious of differences of audible effect produced by the presence of obstacles, &c., and in process of time he would learn to interpret the audible effects, and thus, in a manner — see with his walking stick.

Elaborate later.

AGB

531

1902, January 9 Thursday At 1331 Conn. Ave.

We had a very pleasant Wednesday evening meeting last night, and I am specially pleased with it because the majority of the gentlemen present were not specially invited for that evening, but came simply on the general invitation for Wednesday evenings.

Present: —

Frank Baker

L. A. Bauer

H. C. Bolton

Dr. Swann Burnett

Wm. H. Dall

David Day

Dr. Elmer Gates

F. W. Hodge

Prof. Newcomb

Mr. Chas Walcott

Gen. Sternberg

Mr. Darton

Mr. Kennan

Mr. Zable

G. W. McCurdy

Dr. Owens

Mr. Tittmann

Gilbert Grosvenor

Graham Bell

19 Gentlemen

Mrs. Graham Bell

Miss Graham Bell

Mrs. Gilbert Grosvenor

Gertrude Hubbard

Mrs. Kennan

5 Ladies

Total 24.

Prof. Newcomb, who generally hobbles away early from meetings of all kinds, remained to the very end, and I think had a good time. He described to us his experiments at Baddeck for measuring the light of the sky, and stated that his paper upon the subject will be published in the next number of the Astro-Physical Journal. His remarks were discussed.

Surgeon General Sternberg showed a trick. Stood a walking stick up on the ground between his knees, which remained standing by itself apparently, frictional electricity, &c. the cause. But, subsequent investigation revealed a black thread 532 from one knee to the other fastened with black pins. As the thread was not attached to the stick the trick looked very mysterious.

Mr. Tittmann spoke of the Bureau of Weights and Measures that is to be entirely separate from the Department of the Coast and Geodetic Survey.

Mr. Walcott gave us inside information concerning the Carnegie Institution.

Mr. George Kennan was the speaker of the evening, and read a translation of a Russian story, about a sort of myth s relating to Napoleon, which kept us all in good humor. Mr. Kennan also told two other Russian stories.

Dr. Carrington Bolton also told a story.

Dr. Day described the accomplishments of a conjurer, who is in town at the present time, and thought he might be able to bring him up at the next meeting.

Mr. Hodge spoke of this same man having performed some remarkable tricks at the Geological Survey, while his hands were held by Prof. Gilbert and some other person.

I spoke on kites, and described Prof. Newcomb's article against the possibility of constructing large flying machines as equally applicable to kites, and how I got over the difficulty by cellular construction, and pointed to George McCurdy as having been carried up in the air by one of these kites.

Those who spoke at some time during the evening were: —

Frank Baker, Dr. Bolton, Dr. Burnett, Mr. Dall, Dr. Day Mr. Hodge, Prof. Newcomb, Mr. Walcott, Gen. Sternberg, Mr. Darton, Mr. Kennan, Mr. Tittmann, and A. G. B. and George McCurdy

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I think the evening was thoroughly enjoyed by all present In thinking over the different Wednesday evenings we have had, I have come to the conclusion that we do not want to prepare before hand too much. We do not want the whole evening to be monopolized by one individual. The gentlemen enjoy an informal chat in which all participate, with stories, anecdotes, &c.

Last night was one of the most enjoyable evenings we have had.

A mode of

Mr. Zable has had the transmitter for wireless telephone shown on p. 514 made, by Mr. Schneider, at the workshop of Mr. Ballauf, 732 — 7th Street. I have ordered a second one so that we may experiment with these instruments both as transmitters and receivers. A mode of producing exact synchronism between electrical apparatus in distant places

One great difficulty in the practical construction of autograph telegraphs has been the difficulty of obtaining absolute synchronism between instruments separated by hundreds of miles. There is little difficulty in obtaining synchronism in laboratory experiments, where the transmitting devise may be in one room and the receiver in the next, or perhaps both in the same room. Should one instrument be out of adjustment, it is easy to remedy the defect on the spot, and the two instruments will remain sufficiently in adjustment to enable a large number of experiments to be made. At nearly all our electrical exhibitions, autograph telegraphs have been exhibited in operation in which the receiver copied hand writing or 534 drawings placed upon the transmitter.

Autograph telegraphs of the fac-simile kind have been known for a great many years; but I do not think that any of them have come into practical use, and the reason is probably the difficulty of keeping two instruments many miles apart in exact adjustment with one another. In the case of my own autograph telegraph, patented a great many years ago, the necessity for synchronal apparatus was done away with, but the patent belonged to the American Bell Telephone Company, who had no inducement to push it after the telephone had become successful, and I had no inducement to go on with it, not having an interest in the patent, and having my attention also directed to other things.

The idea illustrated on p. 522, and 523, of releasing a weight at the transmitting and receiving stations simultaneously, seems to me to afford a synchronal arrangement that can be relied upon. Gravity acts alike on all bodies in all places, and, if two similar weights in two different places are simultaneously dropped, they will drop the same distance in the same time. Hence, the only point of art required is to release the weights at the same time. This can be done through the action of electro-magnets as shown on pp. 522 and 523.

Hence, if falling weights are employed in this way, in a copying or Fac-simile Telegraph, we can be sure of the exact copying of a single section of the drawing or writing. Now, if the weights are again lifted up (no matter how) and the cylinders move forward one tick, so that the falling 535 contact rubber would traverse an adjoining section of the drawing or writing, then, by releasing both weights by the electro-magnets again a second section of the drawing or writing would be correctly copied. By successive steps, therefore, the whole writing or drawing could be correctly copied. The process would be comparatively slow, because of the necessity of hoisting up the weights before the tracing of the next line, and the necessity of an electrical impulse to release the weights before the line should be copied; But, it may be possible that a Fac-simi l e Telegraph correctly reproducing what is drawn or written a hundred miles away, might — even if it does the work slowly — be of more value than a more rapid apparatus that DOESN'T WORK successfully at a distance.

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Ladies and Gentlemen: —

The National Geographic Society meets tonight for the first time under its new constitution and By-Laws, as a truly National Society, with its Active membership list not limited to the District of Columbia.

The special object of our meeting is to elect eight managers to succeed those whose terms of office expire by limitation today. We are to elect eight Directors or Managers to serve for three years not more than of whom shall be residents of the District of Columbia.

Before proceeding to the regular business I think it would be well considering the fact that this is the first annual meeting of the Society held under the new constitution and By-Laws (amended) that we should glance backward for a moment at the past history of the N.G.S. and forward into the future at the pathway that stretches before us.

In the past our Society, though National in name, was local in fact, because our Active Membership was limited to residents of the D. C. By our amended constitution this restriction on Active membership is removed. We have become in fact, as well as in name, a national society, and our membership outside the D. C. is now ywice as great as our membership within the District. Washington members constitute only one-third of the membership of the Society, and the Society as a whole gives evidences of growth and life, of activity, of influence.

We stand today at the parting of the ways. The objects that would suffice us as a local society can no longer satisfy 537 our aspirations as a national organization aiming to benifit the whole United States.

Our object is the increase and diffusion of geographic knowledge.

In the past we have done a great deal to diffuse geographic knowledge

Simply map out ideas to br strung together in proper order and connected.

What do we mean by geography?

Surely a very different thing from that of the past. In my younger days the word “geography” recalled a flat map with a long list of hard words and dry facts to be memorized. Today geography recalls not a flat map full of dead words — but a living world, a globe surrounded by an atmosphere containing on its surface land and ocean and life, and within its surface layer above layer the leaves of that wonderful geological book on which is recorded the history of the world before it was inhabited by man, and the forms of life that preceded the present life upon the world. And the oceans are not to our eyes mere lifeless upon the world. And the oceans are not to our eyes more lifeless expanses of salt water, with the eyes of science we penetrate their depths and find mountains and valleys at the bottom of the sea, and countless forms of life inhabiting the waters.

In a word, geography relates to the world we live in, and everything therein contained. What a subject of interest to every man and woman and child.

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As it is our object to increase and diffuse knowledge concerning the world — our knowledge of the land and the water and the air, and the lands that lie under the water and the life of the world in its myriad forms.

Last year we commenced to attend to one department of our work which has hitherto been sadly neglected, the increase of geographic knowledge. While the society was a local society we became accustomed to listening to lectures upon geographic subjects, and to reading the pages of our Nat. Geo. pag., so that the society gradually became passive in relation to geography. We absorbed information that had been obtained elsewhere, but gave little or nothing out to the world as our own contribution to knowledge upon this important subject.

But, during the past year there has been a gradual resurrection of the activities of the society. One half of our lectures have been dropped and technical meetings of the society substituted in their place at which members could bring forward their own contributions to knowledge and at which scientific discussions could take place.

To some persons this has been a dissapojntment. disappointment. They miss one-half of the lantern slides and popular lectures that we used to have; but, to those of our members who have been engaged in original research, these technical meetings have been a stimulus and encouragement —

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1902, Jan. 10 Friday At 1331 — Conn Ave

THE EVENING STAR, MONDAY, DECEMBER 30, 1901

BOARD MEETING. Plans to Promote Work of Instruction to the Deaf.

The board of directors of the American Association to Promote the Teaching of Speech to the Deaf was held Saturday afternoon at the residence of Mr. Alexander Graham Bell, 1331 Connecticut avenue. Plans looking to the organization and establishment of a summer school of training for teachers of the deaf were presented and considered, and definite steps were taken that will lead to the inauguration of the school the coming summer. Teachers of deaf children will receive instruction and training for teaching by the oral method.

Appropriate action was taken relative to the death of Dr. Philip G. Gillett of Jacksonville, Ill., and the vacancy on the board was filled by the election of Dr. Joseph C. Gordon, superintendent of the Illinois School for the Deaf, at Jacksonville, and formerly professor of mathematics at Gallaudet College in this city.

The officers of the board were re-elected to serve during the ensuing year. Those present at the meeting were: President A. Graham Bell of Washington, Vice President A. L. E. Crouter of Philadelphia, Secretary Z. F. Westervelt of Rochester, Mrs. Gardiner G. Hubbard of Washington, Miss Sarah Fuller of Boston, Mr. Edmund Lyon of Rochester and Treasurer F. W. Booth of Philadelphia.

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1902, January 11 Saturday At 1331 Conn. Ave

1902 — Jan 11 — Wash. Post.

GEOGRAPHIC SOCIETY PLANS. Lectures in the Larger Cities to Be Included in Its Programme.

At the annual business meeting of the National Geographic Society, held last night in the hall of the Cosmos Club, the following were elected as managers to serve for three years: Dr. Alexander Graham Bell, Mr. Henry Gannett, Gen. A. W. Greely, Mr. Otto H. Tittman, Dr. W J McGee, Mr. Gifford Pinchot, Dr. Angelo Heilprin, and Mr. Russell Hinman.

The reports of the secretary and the treasurer were submitted, showing a steady growth in membership, especially outside of Washington. Last year the society changed its organic law so as to give it more of a national character. The society intends to exert its effort toward securing outside membership and proposes to undertake the giving of lectures on geographic subjects in the larger cities. Its present out-of-town membership numbers 1,300.

The report of John Joy Edson, the treasurer, showed a balance of $2,25? Dr. McGee offered the following resolution, which was adopted; “That a committee of three be appointed to present and urge before the board of managers of Carnegie Institute, in this city, the importance of advancing the study of geography in its broadest sense.”

541

On Thursday evening January 9 I gave a dinner here to the Board of Managers of the National Geographic Society, following shows the guests and their arrangement at table: —

On Thursday a condenser telephone (a la Dolbear) was completed as a transmitter for wireless telephony, see p. 533. On Friday, January 10, a duplicate was received. In the second instrument the hard rubber ring interposed between the diaphram and metallic back has been omitted and the metallic brass back set into a recess in the hard rubber back:

See following drawing: — (Fig. 2).

542

Yesterday (Friday Jan. 10, 1902) I sent the electrical switch arrangement (made last year to illustrate how electrical tabulation could be made from my system of combinational punching) — down to Mr. Schneider to have four electro-magnets fitted to it by means of which the switches could be worked.

543

Last night (Friday Jan. 10) the annual meeting of the National Geographic Society was held in the hall of the Cosmos Club. Present about fifty members. I made an address upon the growth and future of the National Geographic Society. We elected eight managers, who serve for three years. A good meeting.

Yesterday received following telegram from C. P. Steinmetz, President of Amer. Inst. of Elec. Eng., "New York Jan. 10, 1902. Dr. Alex. Graham Bell, 1331 Conn. Ave., Wash.

The Amer. Inst. of Elec Eng. are to honor S. Marconi at their annual dinner at the Waldorf-Astoria January 13. We desire all past Presidents to attend and trust you also will not fail to be present.

C. P. Steinmetz, (President)."

Have sent a reply stating that I will be there.

Wrote yesterday to Mr. Pope the Secretary of the Institute to ascertain whether ladies would be admitted at dinner, in which case I might take Daisy, also to inquire price of tickets answer received this morning: —

"Very glad you are coming. Tickets four dollars each.

Many ladies will attend dinner seven o'clock.

Ralph W. Pope”

Yesterday morning Mr. McCurdy brought me some specimens of celluloid tubing. This seems to be the very material wanted for floating kites. The specific gravity of celluloid was ascertained for me in Baddeck by George McCurdy as follows: —

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SPECIFIC GRAVITY OF CELLULOID

1.2125

(See Lab. Note Book under date 1901, Nov. 30, p. 134).

Celluloid can be obtained in any form from the Celluloid Company, Washington Square, New York, N. Y.

MACADAMITE

Mr. McCurdy also showed me yesterday, (Jan. 10) a specimen of Macadamite an alloy of alluminum. This was a rod about 2.7 cm. long and 0.5 cm. in diam. Weight under 2 gms. This seems to be a very hard material and yet very light.

AGB

545

My attention has just been directed to an article in the Washington Evening Star, Nov. 16, 1901, by Prof. Simon Newcomb upon aerial flight, which offers a great contrast to his article entitled “Is the Airship coming?” published in McClure's magazine September 1901. Prof. Newcomb was present in Beinn Bhreagh with Prof. Langley and myself during a portion of September 1901, and what he saw there of whirligig flying models, kites, &c. and what he heard in discussions with Langley and myself, have evidently caused him to modify his views to a very considerable extent. Some sentences in the two articles are almost a like word for word, and it is very interesting to note the differences of expression.

Fos example: —

From McClure's Mag. Sept., 1901

“I have shown that the construction of an aerial vehicle which could carry even a single man from place to place at pleasure requires the discovery of some new metal or some new force.”

From Evening Star Nov. 16, 1901.

“What is certain is that no one will ever fly to any great height or to any considerable distance until some metal or alloy is discovered which will combine strength with lightness in a far higher degree than any metal or alloy at present known to us”

AGM

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1902, Jan. 20 Monday At 1331 Conn. Ave.

Gentlemen invited by Mr. Bell for Wednesday evening, 1902,. Jan. 22.

Abbe, Cleveland 2017 I St.

Adler, Cyrus Smithsonian Inst.

Blount, Henry F. The Oaks, Georgetown

Cannon, Frank J. 2148 Mass. Ave.

Curtis, W. E. 1801, Conn. Ave.

Deavitt, Prof. G. R. Washington, D. C.

Farquhar, Henry 1615 Fla. Ave.

Fay, E. A. Kendall Green

Galloway, B. T. Chief Bu. Plant Industry

Gannett, Henry Geological Survey

Gore, J. H. 237 R St., N. E.

Hamlin, Teunis 1306 Conn. Ave.

Hill, Robert T. 1738 Q St.

Smillie, Thos W. National Museum

Tanner, Z. L. 1613 N. H. # e

Winston, Isaac 1325 Corcoran St.

J. A. S.

Also George Kleeman U. G. Robinson, WS Gardiner of Tokyo Japan

Dictated by Mr. Bell: Jan 20, 1902.—

A thin strip of metal is very easily bent in the direction of its thickness — or thinness rather — that is in a direction at right angles to the plane of its surface but opposes great resistance to being bent in the plane of its surface.

547

If then, a thin slip of metal is bent through the middle longitudinally, so that one portion of the surface is at right angles to the other portion, it will resist bending in every direction.

It becomes in effect two strips of thin material at right angles to one another, each strip resisting bending in the direction of its width, and we cannot bend either in the direction of its thickness without encountering the resistance of the width of the other strip.

Here we have a means of making a practically rigid framework out of extremely thin material. We have a means of getting great rigidity without weight.

It has been my wish to make a compound kite of metal using aeroplanes of thin sheet aluminum. I find that we can get aluminum foil that undoubtedly will answer the purpose weighing less than 100 gms. per square meter of surface. We could make the framework of steel, or an alloy of aluminum, or other metal in the shape of wires weighing not more than 8 gms. per meter of length. Steel would do perfectly well, but here come in the practical difficulties— How are you going to fasten sheet aluminum to a steel framework, and steel will oxidise. Bronze, or phosphor-bronze would have all the necessary strength, and would not be so liable to oxidisation. Some of the alloys of aluminum seem to possess the necessary strength and hardness with only a fraction of the weight of 548 steel or bronze.

The specific gravity of brass, steel, bronze and metals of that kind is very little less than 8; whereas macadamite and a specimen of aluminum alloy sent me by the Pitsburgh Reduction Co. have a specific gravity of only about 2.5. Prof. Langley, however says that all the alloys of aluminum have that undesirable characteristic of pure aluminum which he demoninates “doughiness” — a very happy expression — suggestive of “dough”.

I have not been able to find that any practical method of soldering aluminum has yet been perfected, and a note received some time ago from the Pittsburgh Reduction people fails to afford much encouragment in this direction.

The most practicable method of attaching sheet aluminum to a steel wire framework seemed to be to bend the aluminum around the wire, and rivet the two surfaces together

Many objections, however, appear at once.

If instead of using wire we use strips of thin material bent longitudinally at right angles we can rivet the sheet aluminum to the metallic strip

549

One objection is that the thin sheet aluminum would be apt to tear at the rivet holes when the pressure of the wind comes on the aeroplanes.

This could be obviated by bending the metallic slip right over so as to form a clamp — the thin sheet of aluminum being between the two edges, and the rivets holding the whole together as shown below: —

In this, however, we fail to get the resistance to bending we obtained with one half the slip at right angles to the other — the resistance to bending is simply double that of a single slip, because the slip is not doubled upon itself.

Why not treat the doubled slip as we treated the single one — bend a portion of it up at right angles to the rest

In this form the riviting becomes unnecessary. The thin aluminum foil is first firmly clamped between the two surfaces of the metallic slip, and then this slip being bent upwards in the middle at right angles carries with it the edge of the metallic foil, so that the foil is not only clamped between two thicker pieces of metal, but is bent upwards at right 550 angles within the clamp. It would therefore be held firmly within the clamp without riveting at all.

Last night I tried fastening an aeroplane of thin sheet aluminum into a frame made of thicker sheet aluminum, following the above plan

Two slips of pretty thick sheet aluminum (I think alloyed) were cut each 12.5 × 2 cm., which were folded along the dotted lines; also two slips 25 × 2 cm. folded along the dotted lines. A sheet of thin sheet aluminum was then cut, having a surface of twenty-five by twelve and one half cm. The edges of this thin sheet were placed between the bent surfaces of the framework, and these surfaces were then pressed together flat, so that the whole thing looked like the first diagram above — like a slate. The framework being 1 cm. wide, as shown below: —

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1902, Jan. 22 Monday at 1331 Conn. Ave.

The edges of the frame were then turned up along the dotted lines, making the horizontal part of the frame about ½ a cm. wide and the vertical part about ½ a cm. high. The aeroplane and its frame resembling a shallow dish.

The aluminum frame which — before being built sent up at right angles — appeared to be too flexible to be of use as a frame for the aeroplane — at once became rigid when it was bent, as shown above, and the whole frame resists bending to such an extent that it really looks as if it would be practicable to make a frame in this way.

The whole aeroplane, with its frame weighed 9.125 gms. The whole surface (25 × 12.5 cm) equalled 312.5 sq. cm. and the flying weight was less then 300 gms. per sq. meter of surface.

Perhaps it may be feasible to use tin for the frame. I notice that umbrella ribs are now made of thin slips of metal bent somewhat as follows: —

I think they are made of iron or steel, painted or japanned. If umbrella ribs should turn out to be light enough for a kite framework, they would be very suitable indeed.

A.G.B.

5

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THE WASHINGTON POST, WEDNESDAY, JANUARY 22, 1902

Prof. and Mrs. Willis L. Moore entertained at dinner last night in honor of their guest. Mrs. James McAnulty, of Seranton, Pa. The guests were Col. and Mrs. Robert Fleming, Prof. and Mrs. Alexander Graham Bell, Representative Foss, Mr. and Mrs. Rudolph Kauffmann, and Mr. and Mrs. B. H. Warner.

553

1902, Jan. 23 Thursday At 1331 Conn. Ave.

I have neglected to note results of an important experiment made December 24, 1901. Idea developed in Home Notes, under date December 13, 1901, pp. 108 to 118, and specially pp. 115 to 118 9. Advantages of Wooden Frames Over Wire Frames By A. G. Bell. Jan 23, 1902

62 64 18

A wire frame, (or a frame of sticks tied together, as used in Beinn Bhreagh) requires a diagonal brace to keep its form under strain The diagonal, however, represents a considerable percentage of the weight of the frame. It occurred to me that a wooden frame of considerable width — say 1 cm. — if the parts could be doved-tailed together, would resist deformation without the necessity for a diagonal brace. In order to test this idea George McCurdy gave instructions to Mr. Schneider (731 — 7th Street) to make three wooden frames covered with cloth the frames to be 25 × 50 cm. made of wood 1 cm. wide and 1 mm. thick; the wood not to be pine, but some stronger wood like oak, or whatever George might decide upon after seeing Mr. Schneider. The frames were returned to me on December 24 completed made of walnut, covered with linen. Instead of being 25 × 50 cm. however, they turned out to be 30 × 50 cm. 554 one of them a little more than 50 cm. They were evidently intended for 30 × 50 cm.

Each frame with cloth weighed 36 gms., walnut frame 17 gms., linen cloth 19 gms., total 36 gms. Surface 30 × 50 = 1500 sq. cm, flying fling weight 240 gms. per sq. m. of surface, an extraordinarily light aeroplane.

The experiment is perfectly successful in demonstrating that frames of this sort need no diagonal brace, and the weight is so much reduced by the omission of the diagonal brace that we can afford to put the weight saved into thicker material for the frame.

I have today asked Mr. William Brewton — 1505 — 33rd street, W. Wash., D. C., to make two frames of this kind, one 12 in. × 6 in. and the other 24 × 12, of walnut, the material to be # wide and # thick. I consulted him as to the feasibility of making a raised edge all round

He said that this would require a special tool, but perhaps the end might be obtained by making the cross section somewhat as follows, which could be easily done with the 555 tools at his command.

The weight of the frame would be greater in this case, but it could be easily made. I then suggested cutting it down to a knife edge on either side, so as to make the cross section a triangle

This would give width in two directions at right angles to one another, and weigh less than the last form, though more then the first. It has been decided to make the frames in this manner.

AGB

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1902, Jan 25 Saturday At 1331 Conn. Ave.

After Mr. Brewton left here Thursday, Jan. 23, it occurred to me that the thick edge of the frame should be inside, not outside. Mr. Brewton is now making the frame in this way: — in which the thick edge of the frame comes on the outside. Considerable advantage would result if the thick edge should be on the inside, as shown in the following diagram: — It would be specially advantageous to have the edge of the frame cut down to an angle of 30 degrees

Three such frames would then fit together well to make a triangular cell

557

Holes can be bored through the framework by which the different frames can be fastened together. The string or wire used in fastening the frames together would probably not weigh more than the material removed in making the holes, so that the flying weight of a compound structure would not be materially different from a single frame.

10

Yesterday, Friday, Jan. 24, Board meeting Nat. Geo. Soc. at 4.30. Soon after 5 P. M. went to the White House with Mabel to attend Mrs. Roosevelt's Reception. 8 P. M. Scientific Meeting of National Geographic Society at the Cosmos Hall; Magnetism of the Earth by Dr. Bauer, of the Coast and Geodetci Survey, also a paper on Ocean Currents by Mr. Page of the Hydrographic Office. After the meeting took Marian and Sarah Marsh, and George McCurdy to Willards for supper.

A.G.B.

AGB

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1902, Feb. 6 Thursday At 1331 Conn. Ave.

On Saturday evening, February 1st, a dinner party was given here, at which the following persons were present:

Ladies

Mrs. Graham Bell

Miss Graham Bell

Miss Brocklebank

Miss Child

Miss Ffoulke

Miss Foraker

Miss Helen Bell

Miss Maude Marsh

Miss Sarah Marsh

Gentlemen.

A. Graham Bell.

Vivian Burnett

Mr. Schroen

Mr. Wyeth

Mr. Henderson

Dr. Church

Mr. Chapman

Mr. Tyler

Andrew Bradley.

On Monday evening, February 4 Mr. Bell made the following note in Hone Notes, p. 21: —

“Dinner this evening at Prof. Gore's — met Mr. Allen, Commissioner of Patents, and Mrs. Allen, Mr. Varilla, Engineer of Panama Canal Co., — and who started the Dreyfus revision, Dr. Whitman, and Mr. Hill — Consul at Netherlands.” Also Mrs. Gose, & Mr. & Mrs. A. Graham Bell .

On Tuesday evening, Feb. 2, an entertainment was given here, and during the evening Prof. Malini, a sleight of hand performer gave an exhibition. The Evening Times gives the following account: —

(See next page).

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THE EVENING TIMES, WASHINGTON: TUESDAY, FEBRUARY 4, 1902.

MR. WU WOULD LIKE TO KNOW WHERE THE EGGS CAME FROM

Chinese Minister Greatly Puzzled by the Trick of Prof. Melina.

Mr. Wu, the Chinese Minister, was a guest last night at an informal affair at which Mr. and Mrs. Alexander Graham Bell were the hosts, and the Chinese Minister and Prof. Melina, a prestidigitator who has been startling Washington with his remarkable tricks with a deck of cards, furnished more amusement than is usually contained within one short evening.

When Prof. Melina took the deck of cards to begin his performance he singled Mr. Wu out from the guests and asked him to a chair at his side. Then he deftly removed a card from the back of Mr. Wu's neck and the several from one of his flowing sleeves and proceeded to business.

“You musn't steal the cards, you know,” he said to the astonished diplomat.

The Chinese Minister smiled affably and patted the professor on the back. “You are a bright young man.” he said.

After several tricks which considerably astonished Mr. Wu, Prof. Melina looked at the Chinese Minister with commiseration and said: “Mr. Wu, I notice that you have an impediment in your speech.”

Whereupon he rolled up his sleeves to the elbow and, showing his empty hands, placed his palm over the diplomat's mouth and extracted an egg therefrom. At least that is what it looked like.

Mr. Wu denied that he was in the habit of carrying eggs in his mouth while Prof. Melina insisted that the guests had seen his bare hands and pointed to his rolled up sleeves. To prove that the Minister was an involuntary egg basket, he removed three more eggs from various portions of the diplomat's countenance, much to Mr. Wu's amazement and enjoyment.

Then the professor placed a dollar bill in Mr. Wu's hand, instructing him to hold it carefully.

“I will, it won't get away from me,” said Mr. Wu.

Whereupon Prof. Melina uttered some magic words and told Mr. Wu to open his hand, when the diplomat was found to be tightly clutching a piece of newspaper.

Every few minutes during the performance Mr. Wu would rise to his feet and pat the professor on the back. At the end of the evening he said he had a delightful time and spent fifteen minutes trying to get Prof. Melina to tell him where the eggs came from.

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Last evening, Wednesday, Mr. Bell had a very successful gentlemen's party. Only a few special cards were sent out, so that most of the people present came upon the general invitation for Wednesday evenings. The following is a note made by Mr. Bell in "Home Notes", 1902, Feb. 5, p. 22.

"Large meeting this evening. Think about 30 gentlemen. Prof. Willis Moore gave a talk upon storms illustrated by lantern slides. Dr. Swann Burnett spoke of blindness produced by wood alcohol. Capt. Russell spoke of the Philippine war. A Mr. Peters of Naval Observatory spoke of Samatra. Some of the persons present were: —

Willis-Moore, Dr. Swan Burnett, Dr. Fry, Dr. Hamlin, Mr. Hill (Geol. Surv.), Capt. Russell of the Signal Service, Prof. Frisby, Mr. Peters of Naval Observatory, Mr. Allen (Commisioner of Patents), Mr. Robinson, Mr. Archibald, General Randolph, Mr. Arthur W. McCurdy, George McCurdy, Mr. Hitz, Mr. Ferreri, Mr. Carkhuff (Geol. Survey), Mr. Darton, Dr. Dall, Mr. Lucas, Prof. Gore, Mr. Tyler, Prof. Gilbert, Dr. Bauer, Prof. Wigglesworth Clarke, Prof. Bigelow, Mr. Bunker, Mr. Bernard Green, Mrs. A. G. Bell, Mrs. Gilbert H. Grosvenor, Miss Graham Bell, and A.G.B.

31 persons

The following persons spoke during the evening:— Moore, Bigelow, Burnett, Fry, Hamlin, Hill, Russell, Frisby, Peters, Robinson, Archibald, Dall, Tyler, Gilbert, Bauer, Clarke, Bunker, and A.G.B. (18 persons)."

Jean Safford, Private Secretary.

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1902, Feb. 11 Tuesday At 1331 Conn. Ave.

We are to have a dinner party this evening, consisting of the following persons: —

Judge Howry and Mrs. Howry, Col. Bingham and Mrs. Bingham, Mr. and Mrs. Thoron, Mr. Howe and Miss Graham Bell, Mr. Adams and Miss Grossman, Mr. Poor and Miss Ely, Mr. and Mrs. McLannahan, M. Boeufve and Miss Cannon. Mr. and Mrs. A. Graham Bell.

We expect to have an especially interesting Wednesday evening tomorrow, February 12, the subject "The proposed Isthmian sea-level canal through a tunnel by the Mandingo route." Mr. George Kennan will open the subject and introduce General Edward William Serrell, the chief promoter of the tunnel, and the builder of the Hoosac Tunnel. The following persons have received special invitations: —

Those underlined in red were present as Feb. 19

A. G. Menocal, Commander Lucian Young, Arthur P. Davis, Admiral Walker , Senator Hanna, Senator Hawley, Sen. Hansborough , Sen. Morgan, Read.—Ad. Fred V. McNair, Gen. James H. Wilson, Prest. Gilman, Joseph Nimmo , Jr., Ad. Watson, Ad. Taylor, Sen. Spooner, Sen. Scott , Sen. Aldrich, Sen. Allison, Sen. Pritchard, Sen. Foster of La., The Secretary of State, Maj. Black, Gen. Wm. P. Hepburn, M.C., Walter Wellman , Geo S. Morison , Prof. Wm. H. Burr, Gen. Greely , Read Ad. Melville, Gen. Randolph, Capt. Russell , Mr. Peters , The German Ambassador, The British Ambassador, The French Ambassador, The Siamese Minister , The Chinese Minister, The Japanese Minister, M. Boeufve , M. Varilla , Hon. Mr. Hill, Asst. Sec. of State, Hon. Mr. Hill , M.C. from Conn., Carroll D. Wright, Prof. Langley prof. Newcomb, Maj. Powell, Mr. Walcott, Hon. Mr. Merriam, Director of the Census, Dr. Wines , Baron von Kapp-herr , Mr. Adams, M. C., A. Melville Bell, Sen. Platt of Conn., The Chief Justice of the Supreme Court, Justice Brewer, The Secretary of the Navy, The Secretary of War, the Secretary of Agriculture, Governor Taft, Mr. George Kennan , Capt. Bayley, R.N., Capt. Ira Harris , Chas. H. Spencer , Hon.

John W. Foster, Lieut. Conner , The Minister of Columbia represented , The Minister of Nicaragua, Hon. Hillary Herbert, formerly Secretary of the Navy, Mr. Micou, Mr. Ferreri , Gen. Haupt, Gen. Abbott , M. Lampre, Mr. Frank Vanderlip , Mr. Schroen

AGB

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1902, Feb. 17 Monday At 1331 Conn. Ave.

The following table will save much unnecessary labor in calculating flying weights and absolute weights of given aeroplanes: —

The following diagram shows graphically the relative sizes of the aeroplanes referred to above: —

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A light kite should not weigh more than 400 gms. per sq. Metre of surface. A compound kite should consist of light cells with a skeleton of strong material. The whole compound structure to weigh not more than 400 gms. per sq. metre of surface.

I find that it is practicable to make the light cellular part of material weighing about 300 gms. per sq. metre of surface, leaving 100 gms. per sq. metre of surface for the material of the stronger framework, or skeleton (comparing a compound kite with a living creature the strong framework corresponds to the bony skeleton of the creature, the cellular structure to the flesh and blood). The material composing the flat surfaces of the aeroplanes need not weigh more than 100 gms. per sq. metre of surface. Closely woven silk weighs less, cotton and linen fabrics can also be obtained of sufficient closeness to serve the purpose at about 100 gms. per sq. metre. Celluloid and aluminum, in thin sheets, that would answer the purpose can also be obtained at less than 100 gms. per sq. metre of surface.

Allowing then 100 gms. per sq. metre for the aeroplane surfaces themselves, this leav e s 200 gms. per sq. metre available for the light framework necessary to keep the surfaces stretched and in position. We obtain then the following theoretical distribution of weights:—

Light framework 200 gms. per sq. M. of wing surface

Aeroplane surfaces 100 gms. per sq. M. of wing surface

Strong framework 100 gms. per sq. M. of wing surface

Total Kite 400 gms. per sq. M. of wing surface

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In utilizing the table, on p. 561 it will be well to remember that we can calculate the cubical contents of the material employed by dividing its weight in grams by the figure expressing its specific gravity. I find it safe to consider wood (of all ordinary kinds) as weighing half as much as water or having a specific gravity of 0.5.

Suppose then we want to make a light framework to support an aeroplane 50 × 25 cm. (See p. 561), we find that at 200 gms. per sq. M. the wooden frame will weigh 25 gms.. If the specific gravity is 0.5, then the cubical contents of the wood forming the frame will be 25 ÷-0.5 = 50 cu. cm. of wood.

The length of the framework on which to stretch the cloth for such an aeroplane, will be 150 cm. (See p. 561).

Hence the thickness, or rather the cross section of the wood forming the frame will be 50 c. cm. ÷ 150 cm. 50 ÷ 150 = 0.33 sq. cm If then the wood of the framework should be 1 cm. wide, it may be 0.33 cm. thick.

150 × 1 × 0.33 = 50 c.cm.

That is, the frame may be made from a piece of wood 150 cm. long, 1 cm. wide and # cm. thick

564

On Feb. 2, 1902, I weighed some specimens of silk — materials for dresses. See Home Notes pp. 10 and 11.

A A piece of red silk 315 cm. long and 49.5 cm. wide weighed 93 gms.

B A piece of black silk 1328 cm. long and 54 cm. wide weighed 998 gms.

C A piece of light blue silk for a skirt very impervious to air 376 cm. long and 27 cm. wide weighed 98 gms.

FLYING WEIGHT OF SILK FABRIC

A 60 gms. per sq. M.

B 139 gms. per sq. M.

C 97 gms. per sq. M.

On February 10 received from Ballauf a walnut frame for an aeroplane 50 × 25 cm.

This frame weighs 22 gms.

Flying weight 176 gms. per sq.M. of wing surface

Such a frame will do well for light framework. Allowing 100 gms. per sq. M. for the cloth of aeroplane surface, the flying weight of a kite constructed of aeroplanes stretched upon frames like the above, will only be 276 gms. per sq. M. of wing surface, leaving 124 gms.

per sq. M. of wing surface available for heavy framework comparable to bony skeleton. The light framework is abundantly strong for this purpose.

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Why the centre of pressure is in advance of the centre of surface in aeroplanes making a small angle with the horizon — with suggestions concerning the actions of overhopping aeroplanes .

The more I think of the fact that the front portion of an aeroplane is far more efficient than the rear portion, the more I become convinced that the explanation lies in a conflict between direct and reflected currents of air. I imagine that a current of air impinging upon a plane surface at an angle is reflected from that surface and — probably — the angle of reflection is equal to the angle of incidence

If the current (a) were acting alone it would strike the aeroplane at (b). See diagram below . If the current (c) were acting alone it would strike the aeroplane at (d). But if the currents (a) and (c) are acting together, then although (a) will strike the aeroplane at the point (b) its reflected path will interfere with the incident path of the current (c) at some point (x) so that if (c) reaches the aeroplane at all it will not strike it at the point (d), but at some point further back — say (y) with enfeebled force

If we imagine the aeroplane to be made more nearly parallel to the direction of the wind, the interferance theoretically should be greater, the ultimate result bei ng that the resultant surrent at the rear of the aeroplane will be 566 moving either in a direction parallel to the surface of the aeroplane (that is it will exert no pressure upon it) or be deflected away from the aeroplane (in which case a partial) vacuum will exist between the rear current and the surface of the aeroplane, so that atmospheric pressure acting above the rear of the aeroplane will — practically unopposed — tend to push the rear down. This may explain the undoubted fact that a plane surface exposed at a slight angle to the wind tends to turn a back summersalt, the front edge rises, the rear edge falls.

We can also see — on the hypothesis of an interferance between the direct and reflected currents — why aeroplanes should be narrow from before aft, and that the same surface cut into narrow strips separated by large spaces is more efficient than a continuous surface uncut

We can also see — upon this hypothesis — why an aerocurve may be more efficient than an aeroplane. Suppose, for example, that the resultant current at the rear of the aeroplane is parallel to the surface, so that it exerts no pressure upon it, then it is obvious that if we bend down the surface it will be pressed by the current

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My conception of the action of narrow aeroplanes with large spaces between will be understood from the following diagram: —

The reflected currents are blown out through the spaces between the aeroplanes and do not therefore interfere with the direct currents making for the other aeroplanes.

When a current of air passes under a flat surface, and parallel to it, it fails to press up against that surface, so that atmospheric pressure above the surface tending to push the surface down is unopposed by a corresponding pressure from below — witness one form of the pneumatic paradox

Bend down the two ends of a card, as shown and then blow through a tube so as to make a current of air underneath the card flowing along the surface of the table, the card will then bend down as shown by the dotted lines.

568

In a similar manner when the air current at the rear of an aeroplane flows under it in a direction parallel to its surface, it exerts no pressure upwards against that surface, and atmospheric pressure on the upper surface pushes it down, so that the rear of the aeroplane instead of being shoved up is actually shoved down — with an active force due to the pressure of the atmosphere.

THOUGHT: — The reflected current acts disadvantageously because it is under the aeroplane — atmospheric pressure above pushing the aeroplane down where the reflected current occurs: But if we could make the reflected current flow along the upper surface of the aeroplane, it would act advantageously ; for , exerting no pressure upon the upper surface , atmospheric pressure acting upward below would tend to lift the aeroplane instead of depressing it.

Let the narrow aeroplanes (a), (b), (c), (d), be superposed as shown, their front edges being fixed, the rear edges being elastic, so that they can be blown up when the pressure of the wind acts upon them. Then, the current reflected from the under side of (a) will pass along the upper side of (b), — 569 practically removing atmospheric pressure from above (b). In this case, then, the reflected current from (a), in the first place, will not interfere with the direct current tending to press against the under side of (b), so that the wind pressure there will be unaffected. In the second place the absence of atmospheric pressure above (b) and its presence below will give an additional shove upwards to (b). The actual lift of (b) will be the pressure of the wind plus the difference of atmospheric pressure below and above (b).

If this works in practice as well as it does in theory it is of the very greatest consequence because although aeroplanes are separated from one another , with great gaps between , a rigid framework in those gaps is necessary to hold the separated aeroplanes in place. And this rigid framework weighs a good deal and has nothing to support it — it has to be supported by the aeroplanes. In most of our forms of kites the space between aeroplanes in the same horizontal line is twice the width of the aeroplanes themselves, hence the weight of the framework required to hold the aeroplanes in position is twice the weight of the framework required for the aeroplanes themselves. That is, two-thirds of the frame occupy the spaces between the aeroplanes.

If the above plan works every bit of the framework will have its supporting surface.

Another point, the pressure of the air upon each section of supporting surface will obviously cause it to assume a curved 570 form. Somewhat as follows: —

Theoretically, therefore, the resultant forces would not only tend to lift the whole structure but should — theoretically, at least, tend to PROPEL IT FORWARDS AGAINST THE WIND. This seems a paradoxical result, and I must say I am a little afraid of it. Must consider the matter more closely before making up my mind definitely that such a result should be produced.

I can think over it now, and when we go to Beinn Bhreagh we can easily test the matter experimentally. I don't know about this, however, if a kite moved at all against the wind the line would slacken and it would cease to be a kite!

It is easy to see that such a kite — if the string were out so that it should be free to fall, should move forwards in falling.

Would it not also dive. Atmospheric pressure acting upwards on the rear sections in co-operation with wind pressure should theoretically tend to lift the stern so that such a kite would need a tail of different construction to prevent it from diving.

This is surely enough of a dictation for today.

A.G.B.

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1902, Feb. 19 Wednesday At 1331 Conn Ave.

Dinner party here last night, eighteen persons present. I recall the following: —

Mr. and Mrs. Farnum of New Haven, Mr. and Mrs. Arnold Hague, Mr. and Mrs. Chas. J. Bell, Mr. and Mrs. Gilbert H. Grosvenor, Mr. and Mrs. A. G. Bell, Lieut. Conner, Miss Graham Bell, Mr. and Mrs. Archibald Hopkins Miss Aileen Bell, Mr. and Mrs. Spalding, Prof. Emmons.

Mr. Zable obtained for me yesterday specimens of different materials to examine:— Two rods of bone and following kinds of wood: Ash, bass-wood, birch, cabinet-oak, California red-wood, cedar, cherry, chestnut, cypressm hickory, mahogany, quartered oak, poplar, maple, walnut, white pine.

Had slips cut from these, supposed to be ¼ inch square, but I find cross section is much less. The slips are from 28.7 to 29 cm. long, 0.7 wide, 0.7 thick. Today slips have been cut supposed to be #th inch square, but they are much more. I find they are practically 0.5cm. wide, and 0.5 cm. thick.

Should an efficient aeroplane create in great disturbance the air behind it.

The Scientific American of Feb. 1, 1902, contains on p. 75 some reproductions of Marey's photographs of the effect of obstructions of different sorts upon air currents. The effect of an aeroplane is well marked. The stream lines at the rear of the aeroplane — I mean underneath the rear part of the aeroplane,—are practically parallel to the surface. The disturbance produced in the free air behind the aeroplane 572 is very extraordinary. An aerocurve seems to produce less disturbance in the free air, and from this it has generally been concluded that aerocurves should be more efficacious than aeroplanes in serial machines. I am a little doubtful of this. Of course the true test is the lift of an aerocurve as compared with an compared with an aeroplane set at the same angle. In my experiments at Beinn Bhreagh I was disappointed with the effects produced by aerocurves. If the lift was superior to an aeroplane under similar circumstances, it was not markedly so. Theoretically I should be inclined to think that the obstruction that produced the greatest disturbance of the air would be superior to that which produced the least, which is quite contrary to the usually received opinions . For what is lift but the effect of obstruction. The amount of lift is the MEASURE of the obstruction. What gives the lift — that is what occasions the sensible pressure against the surface? — The energy of the moving air. Then surely it is obvious that in so far as the aeroplane receives energy from the air, it must rob the air of energy, and the air will be disturbed.

The more completely the air is robbed of energy the greater should, theoretically, be the disturbance behind the aeroplane.

An aeroplane set at right angles to the air current experiences a pressure that varies directly as the square of the velocity of the wind. This seems to indicate that the aeroplane in this position is very efficient. As the aeroplane is inclined to the wind the pressure upon it diminishes, and the greater part of the pressure is manifested on the front part of the aeroplane. Indeed, I suspect that the rear part 573 of the aeroplane experiences a down pressure so that the action of the wind upon an inclined aeroplane tends to turn it upon an axis. It has a tendency to make a back summersault.

Marey's photographs show that the disturbance produced in the free air behind an aeroplane is greatest when it is at right angles to the air current, and becomes less and less as the aeroplane is inclined, being least when it is presented edgeways, so that in this case, certainly the greatest pressures are produced upon the aeroplane when the air is most disturbed by its presence.

Am very much inclined to think that Marey's results are interpreted by Langley and others in an incorrect manner, and that we will find that in a flying machine that arrangement of surfaces which produces the greatest disturbance of the air in Marey's photographs, will be found to be the arrangement in which a flying machine will derive the greatest support from the air.

However, LIFT is the true measure of efficiency.

Yesterday (Tuesday, Feb. 18) arrived at a very simple way of making a compound cellular kite of wood, or metal; amount of labor involved enormously reduced.

Take thin slips of wood, say for example 5 mm. wide and 2mm. thick, and at points 25 cm. apart bore holes, say 2mm. in diameter.

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The triangular parts of the frame to be made of these slips. Then make rods of circular cross section, say 5 mm in diam. for the sticks on which the cloth is to be stretched, and on each end of a rod of this sort have a projecting peg 2mm. in diameter, that will fit into the holes on the slips. If practicable cut a screw thread on these pegs, — but this is not essential.

Arrange these posts vertically in holes in a board, as a preliminary to fitting on the slips. The following shows the arrangement of posts for a triangular frame 1 M each way, consisting of 25 cm. cells.

Now, glue the tops of the posts and projecting pegs, and then fit in position one set of strips as follows: —

575

Now, glue the slips around the projecting pegs and put on a second series of slips as shown below: —

Now glue this second series of slips around the projecting pegs and put on the third series of slips, as shown below:

If it has been found practicable to cut a screw thread on the projecting peg, make little wooden nuts and screw them on the ends of the projecting pegs, so as to cause the slips of wood to be pressed closely together and to press against the 576 flanges around the pegs, constituting the true ends of the wooden posts, and leave the whole thing until the glue hardened.

After the whole thing has hardened remove the posts from the board, turn the whole thing upside down and put a similar set of strips on the other ends of the wooden rods. This will constitute a very light and firm framework for one set of triangular cells.

I have not attempted to complete the second series of triangles, for fear of confusing the drawing. The above should make a very strong and light framework without the necessity of tying the parts together. It might perhaps be advisable to make these in sets of two, as suggested below.

(See next page)

577

The above method of construction lends itself easily to metallic kites. In place of the strips of wood thin strips of metal can be used, and metallic rods in place of wooden posts.

A double set of cell frames would be advisable to save labor in putting on the cloth or metallic foil to be used for wing surface. The cloth on the one set of cell frames being arranged — say as follows: —

The cloth on the other as shown below: —

I would propose to fly such a kite the reverse way of that shown above, that is upside down, so that the horizontal 578 strip s of cloth (or foil) should be below its supporting frame instead of above. The wind would then press it up against the frame, whereas, if flown in the position shown in the diagrams, the horizontal strips would be blown away from their frames and bag upward, unless attached to the frame by tacking or sewing or other means involving a good deal of labor.

In the above construction very little labor is involved in putting on the cloth. The cloth simply consists of a long strip which is zig-zagged from one bar to the other as shown, and then carried across the top. The only tacking or sewing required being at one point. I do not believe it will be necessary to fasten the edges of the cloth to the slips of wood, or other material constituting the sides of the triangle.

Our Blue-Hill Hargrave kite flies perfectly well without having its edges attached at all. We simply want the cloth or material to be stretched with moderate tightness avoiding looseness or hagginess as much as practical.

Whatever may be the flying qualities of a kite constructed as above, it is certainly the case that the amount of labor involved in its manufacture is inconsiderable compared to the labor of constructing compound kites of sticks tied together at every cross. A.G.B.

579

1902, Feb. 20 Thursday At 1331 Conn. Ave.

The following persons were specially invited to Mr. Bell's gentlemen's meeting last evening, Wednesday, Feb. 19: —

Dr. Geo. Girty, David White , Wirt Tassin , Chas. Schuchert , Prof. F. B. Littell, Prof. J. R. Eastman , Mr. Loftus, Sen. Platt, Lieut Conner, Dr. Church, Mr. Frederick Bancroft, Mr. Henderson, Jr., Mr. S. F. Emmons, Mr. Frank Baker , Mr. S. H. Kauffmann, Mr. F. McGuire, Mr. Chas. J. Bell , Mr. Thoron , Col. Bingham, Prof. F. A. Lucas , Mr. G. H. Peters , Commissioner Allen.

J.A.S.

We had quite a large meeting last night, and I will put down here the names of the gentlemen I can remember as being present: —

Messrs. White, Tassin, Schuchert, Eastman, Frank Baker, Chas. J. Bell, Thoron, Lucas, Peters, Langley, Bunker, Prof. Abbott, Frisbee, Newcomb, Sowers, Allen, Wigglesworth Clarke, Tyler, Baron Kapp-herr)?), Hitz, Zable, Mathers, George McCurdy, Mr. Friedman, Holmes, Maynard, Ferreri, Gallaher, Darton, Gilbert, Grosvenor, McGee, and A.G.B., and I think several others, The following ladies were present: Mrs. Bunker, Miss Mace, Miss Coleman, Miss Safford, Mrs. Hubbard, Mrs. A.G.Bell, Mrs. G. H. Grosvenor, Miss Graham Bell.

Known to be present: 34 gentlemen, 8 ladies TOTAL 42.

Respect also:—

Wooden sticks have been cut out each stick 29 cm. long 5 mm. wide and 5 mm. thick. These slips were supported upon pieces of wood having a square cross section of 7 mm. — one support at either end — so that the slips were 7 mm. above the surface of the table as shown in the following diagram: —

580

The slips were then loaded in the middle as shown above by the weight W, to see how much weight they would support without touching the table. Where the weight recorded is less than 900 lbs gms ., the diameter of the weight pressing on the wood was 3.3 cm.; where it exceeded 900 gms. it was 8 cm., so that, in the former cases the weight was distributed over a portion of the wood only 3.3 cm. long; whereas with the heavier weight it was distributed over a portion of wood 8 cm. long. The following table shows the maximum weights supported by the sticks, without touching the table. They would not support 100 gms. more

WEIGHTS SUPPORTED WITHOUT TOUCHING TABLE.

Grammes Wood

300 Cedar

400 California Red Wood

500

600 Cypress, Poplar,

700 Mahogany

800 Chestnut

908 Bass wood, cherry,

1008 Walnut

1108

1208 Ash, Birch, Cabinet, Oak, Maple, White Pine.

1308

1408 Quartered Oak,

1508 Hickory.

On the following page I give a graphical diagram showing the relative stiffness of the different kinds of wood. The lines indicate by their length the weights supported by the slips of wood without touching the table

581

The cedar slip weighed 3.5 gms., the hickory slip 5 gms. The hickory strip supported 5 times the weight supported by the cedar strip, and weighed itself less than one and one half times the cedar slip.

HICKORY SEEMS TO BE THE WOOD WANTED. Although quartered oak is not much inferior. A.G.B.

582

1902, Feb. 21 Friday At 1331 Con. Ave.

The wooden strips mentioned in yesterday's notes, pp. 579 to 581 were made originally under instructions to make them #th in. square, but they turned out to be 5mm. square. It is obvious, therefore, that they were not carefully or acurately made. They probably vary slightly in their dimensions and a very slight variation of thickness will make a considerable difference in the stiffness or resistance to bending. I do not therefore consider the table on p. 580, illustrated graphically on p. 581, as reliable in all its details.

I had some wooden strips made at Ballauf's, very carefully, and I think they can be relied upon as being accurately made according to instructions. One set consist of sticks 28cm. long, 5mm. wide, and 2mm. thick. In the other set the sticks have the same length and width, but are 3mm. thick. I tested the stiffness of these sticks last night when loaded in the middle.

STRIPS 2MM THICK.

Dimensions of strip in mm. 280 x 5 x 2. Weight supported by strip without touching table in grammes, as follows: —

60 not 70 gms. Cabinet Oak, White Pine

70 not 80 “ Quartered Oak, Walnut

80 not 90 “ Ash, Hickory

90 not 100 “ Birch, Maple

583

STRIPS 3 MM. THICK

Dimensions of strip in mm. 280 x 5 x 3. Weight supported by strip without touching table in grammes as follows: —

240 not 250 gms. White Pine

250 not 260 “ Walnut

260 not 270 “

270 not 280 “ Cabinet Oak, Quartered Oak

280 not 290 “

290 not 300 “ Hickory

300 not 310 “

310 not 320 “

320 not 330 “

330 not 340 “ Ash, Maple

340 not 350 “ Birch

These results do not tally with details relating to the strips 5 mm. thick shown on p. 580, but I think that greater weight should be afforded to the table on this page than to the other on p. 580, because the strips in this case were very carefully prepared by Schneider at Ballauf's, whereas, the slips 5mm. thick were intended to be #th inch thick (about 3 mm.), and so bear evidences of inaccurate manufacture. Then again, the weights supported above are accurate to 10gms.—that is the slips would not support 10 gms. more without touching the table, whereas in the result shown on p. 580 the results were accurate only within 100 gms. That is, the strips would not support 100 gms. more than the weights noted without 584 Thursday touching the table.

The differences of stiffness between strips 2mm. thick and 3mm. thick is very remarkable, indicating that with thin strips of this character a very slight change of thickness makes an enormous difference in the resistance to bending.

If we take the weights supported by the 2mm. strips and compare them with those supported by similar strips 3mm. thick we find that although the thickness is only increased one half, the resistance to bending is increased about four times. The weight of each strip, of course, varies directly as the thickness. The resistance to bending seems to vary more nearly in the proportion of the cube of the thickness—it may be an even greater ratio. Compare the weakest wood noted—White Pine at 2 mm. thick and 3mm. thick. The cube of 2 is 8; the cube of 3 is 27; the weight supported by the 2 mm. strip was 60 gms., If this should vary as the cube of the thickness, then: —

The actual weight supported by the 3 mm., strip of White Pine is greater than this, namely 240 gms.

The error of observation is probably greater in the case of the thinner strip than the thicker.

As the weight of a strip increases directly as the thickness; and the resistance to bending in some greater 585 proportion (probably the cube) it is obvious that it would be advisable in the manufacture of a kite to use the thickest sticks consistant with proper flying weight.

I have decided to have some sticks of larger size very carefully made at Ballauf's. The results will probably be less liable to error than those obtained in the case of thinner strips. I adopt as my standard a stick 1 Metre long, having a cross section of 1 sq. cm. This size will also be of value in determining the specific gravity of the various woods. Weigh the sticks and divide by 100, and you have the weight of 1 cu. cm. of the wood, and that weight represents the specific gravity of the wood. A.G.B.

See Scientific American for 1902, Feb. 22 for the following articles: —

p. 125 Gliding Experiments by Messrs. Wilbur Wright and Orville Wright

p. 121 The Santos Dumont Air Ship No. 7

p. 121 The Ethcograph Ethograph

See Also Supplement to Scientific American 1902, Feb. 22

p. 21859 Aerial Navigation Problems by Carl E. Myers.

586

1902, Feb. 22 Saturday At 1331 Conn. Ave.

Yesterday Mr. Zable secured specimens of wood, which were trimmed down at Ballauf's into sticks each 100 cm. long, 1 cm. wide, and 1 cm. thick. The following table shows the names of the different kinds of wood and their weights as ascertained by Mr. Zable.

Woods Alphabetically arranged

Ash 63 gms

Birch 76 “

Hickory 83 “

Linwood 45 “

Maple 73 “

Oak (Cabinet) 77 “

Oak (Quartered) 62 “

Pine (White) 47 “

Spruce 43 “

Walnut 70 “

Woods arranged in the Order Of their Weights

Weight in gms. Name of Wood

43 Spruce

45 Linwood

47 White Pine

62 Quartered Oak

63 Ash

70 Walnut

73 Maple

76 Birch

77 Cabinet Oak

83 Hickory.

RESISTANCE TO BENDING

Last night a stick of wood 100 × 1 × 1 cm. was supported by its ends upon two other sticks, as shown above—so that if straight—its lower surface should be 1 cm. above the surface of the table. The stick was then loaded in the middle by the weight W until the under surface of the stick touched the table. The weights were increased successively by 50 gms. at a time. The sticks would not support 50 gms. more than shown below without touching the table. The 587 experiment was tried four times with each stick—once with side A down; once with side B; once with side C; and last with side D down. The four observations in each case were added together and the mean taken. The results are given below:

SIDE DOWN KIND OF WOOD ASH BIRCH HICKORY LINWOOD MAPLE OAK Cabinet OAK Quartered PINE Wt. SPRUCE WALNUT A 300 600 700 600 500 350 450 550 550 450 B 450 900 250 450 550 350 400 500 500 550 C 400 900 400 350 450 200 350 550 400 550 D 400 600 950 550 450 200 450 650 550 500 Average 1550 3000 2300 1950 1950 1100 1650 2250 2000 2050 387.5 750 575 487.5 275 412.5 562.5 500 512.5

In the following table these specimens of wood are arranged in the order of their resistance to bending. One the average they would not support a load of 50 gms. more than the figures mentioned below without touching the table.

Load in Grammes

275 Oak (Cabinet)

387.5 Ash

412.5 Oak (Quartered)

487.5 Linwood

487.5 Maple

500 Spruce

512.5 Walnut

562.5 Pine (White)

575 Hickory

750 Birch

The above results are shown graphically in the following diagrams:—

588 589

DICTATION

A close examination of the Metre sticks (with cross section of 1 sq cm.? shows that few of them were perfectly straight. The Hickory stick, especially, was manifestly bent.

This suggested the explanation of the erratic behavior of hickory as compared with the other woods in the experiments noted on p. 580 and those noted on pp. 582 and 583

Of course, if a stick is not straight, but bowed up or down, it will take a greater load to force it down to the table if its is convex above than if it is concave.

This matter was tested with the thin hickory strips noted on pp. 582 and 583. The strip 2mm. thick supported 70gms. with one side down, and then when it was turned over so as to put the other side down it supported 80 gms.

The hickory strip 3 mm. thick supported 280 gms. with one side down, and 330 with the other side. In estimating, therefore the resistance to bending, it seems advisable to take at least two observations; one with one side down and the other with the other side down; add together the results and calculate the mean.

In the experiments noted above with Metre sticks, having a cross section of 1 sq. cm., the four sides are marked A , B , C , D , and four observations have been taken with each stick, one with the A side down, the other with the B side. 590 the third with the C side, and the last with the D side. Then the four observations have been added together and the mean. taken. The small dots on the first diagram on p. 588 show the individual observations for each stick, and the distance of the dots apart from one another indicate the extent to which the sticks were normally bent. The hickory stick with the side D down supported 950 gms. without touching the table; whereas when it was reversed so as to have the B side down (D side then being up), it would only support 250 gms. The difference between the maximum and minimum load supported being in this case 700 gms. I look upon the difference between the maximum and minimum load supported by the same stick with different sides down as a measure of its crookedness; the less the difference the less the crookedness, and vice versa .

In the following table the wooden sticks are arranged in their order of crookedness, as indicated by the difference between the maximum and minimum loads supported: —

DIFFERENCE IN GRAMMES

100 Maple, Oak, (Quartered), Walnut

150 Ash, Oak, (Cabinet), Pine (White), Spruce

200

250 Linwood

300 Birch

350

40

450

500

550

600

650

700 Hickory

From these results I conclude that Hickory is apt to be a crooked wood, and would therefore not be very suitable for use 591 in a kite. If the sticks constituting the kite frame are not perfectly straight, the kite goes off to one side, and may even be steered by its own crookedness into a circular path so as to whirl round and round on the string as an axis.

The second diagram on p. 588 is specially interesting as it compared the actual weights of the sticks with the loads carried by them, without touching the table.

Linwood and Maple, for example support about the same load; but the linwood stick only weighed 45 gms.; whereas the maple stick weighed 73 gms. Oak is a great disappointment. Cabinet Oak supports the least weight of any in the table, but is itself one of the heaviest of the woods.

Linwood, maple, spruce, walnut, are all substantially equal in their resistance to bending. They bear a load of about 500 gms.; but how different the weights of the sticks. The maple stick weighed 73 gms., and the walnut stick 70 gms. whereas the linwood stick weighed only 45 gms. and the spruce stick only 43 gms.

White pine and hickory were markedly superior to the others named in their resistance to flexure, and were about e qual to one another; but the pine stick weighed only 47 gms.; whereas the hickory stick weighed 83 gms. The pine stick was practically straight; whereas the hickory stick was considerably distorted.

The wood that offers the greatest resistance to deflection seems to be birch; but it is a heavy wood, the birch stick weighing 76 grammes..

592

GENERAL RESULT

Upon the whole birch seems to be the strongest wood we can employ of all those mentioned in the table. Former experiments with birch strips 2 and 3 mm. thick, and those with a square cross section of 5 mm. confirm this conclusion.

Birch, however, is a heavy wood, and where we desire to economize in weight, even though we sacrifice degree something in strength white pine combines in a remarkable degree strength and lightness. Spruce, the lightest of all the Metre sticks comes out well in its resistance to bending; in fact there is no other wood, with the exception of white pine, which combines in so remarkable a degree strength with lightness. Linwood however, is hardly inferior to spruce.

For ordinary kites, therefore, I should choose first spruce, second linwood, third white pine; and where great strength is required I would choose birch. A.G.B.

Ages Agb

593

1902, Feb. 24 Monday At 1331 Comm. Ave.

Copied from Home Notes, p. 80, dated Feb. 22, 1902.

Both weight and strength should be taken into consideration. We not only want to use that wood which is strongest — but that which is strongest in proportion to its weight .

We are limited as to weight. If we can use one of the heavier woods by employing sticks of a certain cross-section — then we can use thicker sticks of a lighter wood.

For example: —

Spruce (100 x 1 x 1) weighs 43 gms. and supports 500 gms.

Maple (100 x 1 x 1) weighs 73 gms. and supports 487.5gms.

Here the lighter wood supports the greater weight without touching the table. But, suppose them equal — both 500 gms. and suppose we can make a kite of maple sticks weighing 73 gms. then it is obvious that we can also make it of spruce weighing 73 gms. — and as the 43 gms. spruce was as strong as the 73. gms. maple — the 73 gms. spruce will be very much stronger If the resistance to flexure varies at anything like the rate of the cube of the thickness, the increase of strength would be enormous. This much is obvious that we can use thicker sticks of spruce than of maple and hence get a much stronger framework with the same weight.

Make table showing ratio between weight and load as follows: —

Weight: Load:: 1: x.

594

Copied from Homes Notes, p. 81, dated 1902, Feb.22.

Weight in gms. Load in gms. Ratio of Weight to Load Ash 63 387.5 1:6.15 Birch 76 750 1:9.87 Hickory 83 575 1:6.93 Linwood 45 487.5 1:10.83 Maple 73 487.5 1:6.68 Oak (Cabinet) 77 275 1:3.57 Oak (Quartered) 62 412.5 1:6.65 Pine (White) 47 562.5 1:11.97 Spruce 43 500 1:11.63 Walnut 70 512.5 1:7.39

WOODS ARRANGED IN THE ORDER OF THE RATIO OF WEIGHT TO LOAD.

3.57 Oak (Cabinet)

6.15 Ash

6.65 Oak (Quartered)

6.68 Maple

6.93 Hickory

7.39 Walnut

9.87 Birch

10.83 Linwood

11.63 Spruce

11.97 Pine (White).

(Copied from Home Notes p. 82, dated Sat., Feb. 22, 1902).

Other qualities should be investigated, brittleness especially .

What loads will similar sticks support without breaking — That is an important point.

595

The above diagram illustrates graphically the table on p. 594 in which the specimens of wood are arranged in the order of the ratio of weight to load. The figures refer to specimens of wood 100 cm. long, 1 cm. wide and 1 cm. thick supported by their ends horizontally above the table at a distance of 1 cm. from the table. See drawing on p. 586.

The figures show the load supported by each stick without touching the table in terms of the weight of the stick. Thus, the stick made of cabinet oak would only support, without touching the table a load 3.57 times its own weight, whereas 596 the stick of white pine supported a load of nearly 12 times its own weight (11.97).

The diagram shows that four of the woods tested were markedly superior to the others in the proportionate load they could sustain. These are, in the order named, white pine, spruce, linwood, and birch. Three of these, pine, spruce and linwood, are light woods, (the specimens weighing respectively pine 47, spruce 43, and linwood 45 gms.); and the fourth, birch is a heavy wood (specimen weighing 76 gms.)

While it is true that a framework made of light wood of the same weight as a heavy wood would be of greater thickness (and hence in the cases considered of greater strength), it is also true that the thicker wood would offer greater resistance to the air than the thinner wood, so that, given two frameworks of equal weight, one made of specifically heavy wood, and the other of specifically light wood — then the specifically light framework would be more retarded in its passage through the air (if it constitutes the basis for a flying machine) — or, if it constitutes a kite, the wind would have much more power upon it in increasing the element of drift — an undesirable element —

I am not at all sure that we should be guided entirely by the weight, I mean specific weight, of our materials, indeed I am inclined to think that where we have two specimens of equal strength (resistance to bending) the one that has least diameter or thickness is the one most suitable for our purpose, because it will resist the air least.

597

I have hitherto considered the strength of a specimen of wood to be demonstrated by its resistance to bending. Taking specimens of equal length and equal cross section supported horizontally at both ends and loaded in the middle — I have assumed that that wood which would support the greatest weight with the least bending was the strongest wood: and under this definition of strength birch comes out away ahead of the other woods. See diagrams p. 588. But there is another quality akin to strength — if indeed it does not more truly indicate strength — it is resistance to breaking. It is conceivable that we may have a wood that will bend very little under a heavy load, and then snap suddenly in two. On the other hand we may have a wood which may bend under a comparatively slight weight, and yet not break under a heavier load than the other. Which is the stronger? Which is the more desirable characteristic for the wood of our framework?

Last night I took the strips of wood 2 mm. thick mentioned on p. 582, and attempted to bend them as shown in the following diagram: —

The details of the experiments are described in Home Notes pp. 83 to 86, under date Feb. 23. The birch strip was the only one the two ends of which could be brought any where near together without breaking. The other woods — even hickory — broke before they were bent into a semi-circle.

598

The two ends of the birch stick were safely brought together — but the strain was too great for the material and after a little while the stick broke while held in this position. The cabinet oak was very brittle, when bent a very little way it snapped into three pieces. The fracture of the pine indicates a brittle wood, but the two fragments remained practically straight after the stick was broken. The fragments of the maple stick also seemed straight. The hickory did not break completely through, and the two unbroken portions appeared to be straight. One of the fragments of the birch strip was straight and the other bowed, thus retaining a set. The ash stick, also exhibited a slight permanent bend. One of the walnut fragments was also slightly deformed. There were no spruce or linwood strips 2 mm. thick, so breaking experiments were not made with these woods.

Of all the kinds of wood mentioned above it is certain that birch will stand the greatest bend without breaking.

I broke up the fragments of all the sticks with one hand into little pieces. They one and all (excepting birch) seemed weak. Birch is remarkably tough — can twist it into a sort of rope without breaking, and can bend it into a bow shape. When bent, however, it retains a set . This feature is rather a dangerous one.— Distortion in the kite frame occasioning eratic behavior in the kite.

599

In my Home Notes, p. 86, dated Feb. 23, I conclude the notation of experiments as follows: —

“The properties of birch are somewhat remarkable. It resists bending better than the other woods, and supports bending better.

It takes more force to bend it — and bends more than the others before breaking. These are valuable qualities.

Although one of the heavier woods — its stiffness is so great that it compares well with the lighter woods in ratio of weight to load. (See p. 82).

While spruce, linwood, and pine, would give a greater resistance to bending for the same weight — they would have to be much thicker — and this would lead to increased air resistance .

I am a little doubtful about using the lighter woods — because we ojly get the strength desired — by increasing the thickness of the individual sticks — which will increase their resistance to the air — and thus lead to an increase of the element ‘drift’ — which is undesirable.

QUERY : — Given sticks of equal resistance to bending — are not those that have the smallest cross — sections the most desirable — as they will meet with less air resistance.

Go ahead and try a frame of B I R C H .

A.G.B”

In my Home Notes, pp. 87, and 88, I calculate the weight of a double frame of birch for a triangular frame of 200 cm. made of 25 cm. cells. Total weight would be 1140 gms., using strips 5mm. wide and 3 mm. thick, and cross bars 5mm. wide and 5mm. thick. This yields a flying weight of 339 gms. per sq. Metre for the light framework alone; or 439 gms. for the kite completed without any heavier frame — rather too great a weight for a light kite.

It would be better to calculate 50cm. cells.

Using strips 5mm. wide and 3mm. thick, and cross bars 5mm. wide and 5 mm. thick, the double framework for a 200cm. 600 compound cell could be made from 1500 cu.cm. of wood. If of spruce at specific gravity .43, this would weigh 645 gms.; if of linwood (sp.gr. .45) 675 gms. If of pine (Sp.gr..47) 705 gms If of birch (Sp.gr. .76) 1140 gms.

The cloth surface of such a compound cell would be 3.3750 sq. Metres, and this enables us to ascertain the flying weight of the frame if composed of spruce, linwood, pine or birch.

WEIGHT OF FRAME

Actual weight in grammes Flying Weight in grammes per Square Metre. Spruce 645 191 Linwood 675 200 Pine (White) 705 209 Birch 1140 339

If we allow 100 gms. per sq. M. for the cloth surface, the following would be the flying weights of kites made of the materials named without any other heavier framework .

FLYING WEIGHTS INCLUDING CLOTH.

Spruce 291 gms. per sq. M.

Linwood 300 " " "

Pine 309 " " "

Birch 439 " " "

It is obvious that a compound 25cm. celled kite can be made of spruce, linwood, or pine which will carry a strong framework weighing 100 gms. per sq. M. and yet the whole be a light kite approximating 400 gms. per sq. M.

This cannot however be done with birch. Of course the birch kite, (which would weigh somewhere about 539 gms. per sq. M. including the strong framework) would fly, but it 601 would not prove to be a very light kite. Whereas, kites of spruce, linwood or pine would fly with hardly a breath of air and come down very lightly.

In my Home Notes at the bottom of p. 90, dated Feb. 23 I have made a preliminary calculation concerning the weight of a light frame of a 200 cm. (50 cm. celled) kite, in which the triangular part would be made of wood 1 cm. wide and ½cm. thick, with cross bars of 1 sq. cm. of spruce. I am surprised to find that the flying weight of the frame comes out as 172 gms. per sq. M., which is less than the flying weight of the 25cm. celled frame (191 gms. per sq. M.). Am inclined to suspect some error. Will make a more careful calculation of the weight of such a frame and it may be possible that we could make it of birch and have it come within our limits of weight for a light kite

Am inclined to think that a 50cm. cell is a good size to adopt for our unit cell. The wood forming the frame may be thicker than in the case of the 25 cm. cell, and this gives more room for screwing together the parts. It will give solidity to the light framework. The smaller the unit cell adopted the weaken must be the sticks composing the light framework.

The heavy framework is intended to be strong enough to carry up a man: Would it be safe to have such a frame carried up BY EGG SHELLS! A.G.B. AGB

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1902. Feb 28 Friday At 1331 Conn. Ave.

THE EVENING STAR, WEDNESDAY, FEBRUARY 26, 1902—

Mr. and Mrs. B. H. Warner entertained at dinner last night, their guests being Mr. and Mrs. William Alden Smith, Mr. and Mrs. Charles B. Landis, Col. and Mrs. Robert I. Fleming, Mr. and Mrs. D. C. Phillips, Gen. and Mrs Eli W. Torrance, Dr. and Mrs. Alexander Graham Bell, Solicitor General and Mrs. Richards, Miss Aiken, Miss Cannon, Senator Fairbanks and Col. F. A. Richardson.

Tuesday, February 25 I left for New York by the mid-night train. Charles Thompson turned up on the train having been sent by Mabel to look after me in New York. Wednesday morning, February 26, attended a lunceon to Prince Henry at Sherry's, caught 3.25 train for Washington. Found Marian on board. She went up to New York to be present at the launching of the Kaiser's yacht, staying with Lina McCurdy in New York. She returned with me to Washington. Prof. Langley was on board also returning from the lunceon to Prince Henry. Had a good long talk with him upon matters concerning flying machines. In the same car we found Secretary War (Root), Miss Roosevelt, and others of the President's party who had been attending the launching of the Kaiser's yacht. Reached home soon after half past eight, P. M. Wednesday, Feb. 26, and found a number of gentlemen had already arrived. Charlie and Bert were in charge. During the course of Wednesday evening there were present: —

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C. J. Bell, Gilbert Grosvenor, George McCurdy, Mr. Zable, Mr. Hynson, Mr. Ferreri, Dr. Hart Merriam, Prof. Lester F. Ward, Mr. Bernard Greene, Mr. Bunker, Mr. Robinson, Mr. Friedman, Mr. Van (?) connected with the Dutch Legation, Dr. Swann Burnett, Dr. Simpson, Mr. Gannett, Mr. Coville, Dr. Hamlin, and perhaps one or two others. Ladies present:— Mrs. A. G. Bell, Mrs. Gilbert Grosvenor, Miss Coleman. Total 19 gentlemen, 3 ladies; Total 22 persons.

I am very much gratified at this because no special invitations were sent out for that evening, and all who came came simply on the general invitation for Wednesday evenings. I had made arrangements with Mr. Arthur W. McCurdy to exhibit the Ebedec—take a flash light photograph of the company assembled and develop the picture right before them in the light. He however, was detained in Rochester so this feature was omitted, and there being no programme the gentlemen were called upon individually for items of interest. We had stories and anecdotes from Mr. C. J. Bell, Dr. Hart Merriam, Mr. Bernard Greene, Mr. Bunker, Mr. Robinson, Mr. Friedman, Mr. Gannett, Mr. Coville, Dr. Hamlin and A.G.B. Dr. Hart Merriam also gave us an account of the history of the Bogoslov Islands; also a description of the Mongoose, and how it has exterminated the ground birds &c. in some of the West Indian Islands, forcing the rats to nest in the trees. He also gave an account of the Great Bear of Kadiac Island, the largest bear in the world—twice as large as a grizzley and which attacks man on very slight provocation. Mr. Bunker told us a thrilling incident of his experience among the 604 Modoc Indians. Altogether I think we had a pretty good Wednesday evening.

I received the other day an important letter from Mr. McCurdy dated Rochester February 22, 1902., in which he says: — “Dear Mr. Bell: —

Today I formulated the theory and proved that hypo. could be added to any (or my?) developer in the Ebedec and the usual results be obtained.

I took Mr. Eastman's formula of pyrogallic acid — developer — poured sixteen (16) ounces into the Ebedec — put on the cover and rotated a film in this solution for three minutes — then added (through the rubber funnel tube) sixteen (16) ounces of hypo solution to the developer — rotated the film for ten minutes more and withdrew from Ebedec perfectly developed and fixed — no trace of fog. Every one surprised and pleased.

Mr. Eastman's objection to ‘fog’ present in pyroentiction (?) development seemed fatal to my enterprize.—Now, however, everything is different. I have opened up still another field in photography—and you can readily understand that now the user of the Ebedec can obtain his developing solution anywhere and is not to be confined to pyrocatiction (?).

Of course the rubber funnel tube is not necessary,—as there is nothing ‘ to pour off ’ — as was the case when it was supposed to be necessary to pour off the developer and wash the film before pouring in the hypo. All that is now wanted is some means to pour i nthe hypo. at the end of development — say three minutes — a hole in the cover will do.

Yours sincerely, (Signed) Arthur W. McCurdy”.

It really looks as if Mr. McCurdy is going to make a success of the E bedec commercially in spite of all his difficulties in inducing business men to go into it.

Last night received from Mr. McCurdy the following telegram which seems to indicate that the end of his difficulties is at hand: —

605

TELEGRAM.

"Rochester, N. Y., Feb.27, 1902. To Mrs. Graham Bell, 1331 Conn. Ave., Washington, D. C.

Have concluded contract with Eastman. Will return Saturday.

Arthur W. McCurdy".

Yesterday Miss Mary Garrett accompanied by Miss McMahon brought some little deaf children here where they had lunch. In the course of the afternoon Dr. and Mrs. Hamlin called to see the children. Daisy took them upstairs to be weighed and they had a great time over the weighing machine. I find the following record in my Home Notes p. 101, under date Feb. 27: —

"Anna de Angeli, 13 years old, weight 94 lbs.;

Minnis Nandascher, 12 years old, 84 lbs.

Mary Saunders, 5 years old, 39 ½ lbs.

Sammie Stakley, 9 years old, 57 ¾ lbs.

Raymond H. Bartsch, 13 years old, 87 ¾ lbs.

Albert V. Eewards, 15 years old, weight 118 lbs."

Miss Garrett is attending the Mothers Congress here. She read a paper before the Congress illustrated by the children. The older children are attending hearing schools.

A.G.B.

AGB

606

1902, March 3 Monday At 1331 conn. Ave.

My birthday. Since I am informed that I was born in the year 1847 for I can't speak from personal recollection—and having made elaborate calculations according to a young friend of mine who shall be nameless, I reach the result that I am 5.5 years old today!

Saturday, March 1, 1902, was my father's birthday; as he was born in 1819, he was 83 years old on Saturday. We had a family dinner here in his honor

The above was the arrangement of the table. We had hoped that Miss Safford could have been present, but she was unable. Miss Aileen Bell was unable to be present at the dinner but came in afterwards in the course of the evening. Later on in the evening Mr. Arthur W. McCurdy arrived from Rochester, New York.

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Present at the dinner: —

Mr. and Mrs. A. Melville Bell, Mrs. Gardiner G. Hubbard, Mr. and Mrs. Charles J. Bell, Mr. and Mrs. Gilbert H. Grosvenor, Mr. and Mrs. A. Graham Bell, Miss Hattie Mace, Miss Marian H. Graham Bell, Miss Louise Coleman, Miss Mary Symonds, Miss Louisa Symonds, Miss Helen Bell, Miss Grace Bell,; Mr. George McCurdy, Mr. Chester Kerr, Mr. Gardiner Bell, Mr. Robert Bell, (Bobbie — who was perched up upon two cushions to reach the level of the table). Last but not least Mr. John Hitz.

Present after dinner: — Miss Aileen Bell and Mr. Arthur W. McCurdy.

Mr. McCurdy reports having disposed of all his patents to the Eastman Kodak Company of Rochester New York under an agreement satisfactory to him. Mr. Eastman presented Mr. McCurdy — as an honorarium to cover his expenses, &c. — with a check for two thousand five hundred dollars. This shows to me that they mean business. It really looks as though the end of his difficulties are at hand. He has worked long and steadily at his photographic inventions — which are undoubtedly important — and if any man does — he DESERVES SUCCESS.

The following is a drawing I made for Ballauf of a frame to support an aeroplane 25 × 12 ½ cm. The frame was made of spruce on Saturday March 1, and, when completed was calculated to weigh 6.57 gms. Actual weight turned out to be 7.30 gms.

608 609

The frame seems to be wonderfully strong, but theoretically needs another diagonal brace. The frame seems to be so strong that it is possible that the width of the strips (5mm.) may be reduced perhaps to 4 mm., which should enable us to put in the missing brace without exceeding allowable weight. Mr. Ballauf is now making another frame of similar dimensions excepting that the sticks composing it will be 4mm. wide instead of 5. The following diagram will give a general idea of its appearance: —

(See this Vol. 1902,Feb.19,pp.573 to 578).

Have completed details of a frame for a 100 cm. triangular cell compounded of 25 cm. cells. The difficulty of putting on the cloth on such a celled kite led me to the alternate arrangement shown in photograph taken 1901, Nov. 23, see these notes p. 495, under date 1901, Dec. 11. This plan involved having a double framework for each complete set of cloth cells, ½ of the cloth being placed on one framework and the other half on the other. The disadvantage here is that we double our framework for a single set of cells, thus the framework weighs twice as much as is theoretically necessary for the support of the cloth. The following diagram 610 shows the arrangement of the cloth proposed on one of the frames. See also p. 577.

The above arrangement practically gives us 18 aeroplanes on this frame each 25 × 12 ½ cm. Each aeroplane having a surface of 312.5 sq. cm., gives a total cloth surface of 312.5 sq. cm., gives a total cloth surface on the frame of 5625 sq. cm. (The second frame carrying the bulk of the cloth required to complete the cellular arrangement (see p. 577) would have still less surface, having only 12 aeroplanes, each 312.5 sq. cm.) so that the two frames together would support only 30 aeroplanes, being an average of 15 apiece.

I now propose to use only one frame, and to arrange the cloth as follows. (See Home Notes p. 116, under date March 1, 1902).

This arrangement gives us practically 24 aeroplanes each 25 × 12 ½ cm. on a single frame. Total surface 24 × 312.5 = 7500 sq. cm.

The arrangement first shown above gives a surface of only 5625 sq. cm.; whereas the new arrangement gives us 611 7500 sq. cm. on the same frame.

The flying weight of the single frame carrying 24 aeroplanes is less than the flying weight of the two frames formerly proposed carrying together 30 aeroplanes.

I propose to make the cross bars for the support of the cloth cylindrical, so that the cross section will be a circle instead of a square.

The following equations show the aerea of the circle in terms of the radius and diameter: —

AREA OF CIRCLE

1. Area of circle = #r2

2. Area of circle = diameter 2 × 0.7856

The following table showing the area of cross section of cylindrical sticks may be of value in calculating the weights of such sticks: —

Diam. in mm. Area in Sq. mm.

1 .7854

2 3.1416

3 7.0686

4 12.5664

5 19.6350

6 28.2744

7 38.4846

8 50.2656

9 63.7074

10 78.5400

(For calculations see Home Notes, p. 121)

612

George McCurdy and his father were here yesterday Sunday March 2, 1902, and George McCurdy told us of an idea he has for an improvement in the process of developing and fixing photographic films in his father's Ebedec. Mr. McCurdy's plan at present is: — He pours into the Ebedec a developing solution: revolvs the apparatus for about thre? minutes, and then pours in fixing solution (hypo. I think) George McCurdy proposes to accomplish the same result by pouring in first plain water, revolving the apparatus for about three minutes, and then pouring in the fixing solution.

When asked how the picture was to be developed before it was fixed he proposed he said to have the developer in the BLACK PAPER used by the Eastman Company to protect the film from light. The black paper would of course be dry so that the developer would not affect the film if it contact with it, but as a matter of fact the black ?ouches the other side of the celluloid so that it does not come in contact with the film. The film — black paper and all — is placed in the Ebedec. Then when the water is poured in the developer on the black paper is dissolved and acts upon the film. Thus, the person operating the Ebedec would only have to prepare one solution — the fixer or hypo. solution.

I asked George McCurdy to make a memorandum of his idea in my Home Notes, which he did on p. 122, as follows:

"1902, Mch. 2 Sunday At 1331 Conn.Ave.Wash."

Have thought of the idea of having the developer for developing a film in the black paper, instead of mixing the developer every time. All that you will have to do will be to add water and then after the film has been developed pour in the hypo and fix. Just told Mr. and Mrs. Bell, Daisy and Papa.

(Signed) D. George McCurdy."

613

This memorandum is witnessed in my Home Notes, p. 122, under date March 2, 1902 by Mrs. A. G. Bell, Marian, A. G. Bell, and Arthur W. McCurdy, as follows: —

"M.G.Graham Bell, Marian H. Graham Bell, A.G.B., Mc."

Distance of fog-signal?ay be ascertained by observing the difference between the time of through water and through air.

Last night Sunday March 2, 1902, made the following note in Home Notes p. 123 concerning a new idea:—

"Strike blow on end of submerged stick or post and the sound should be conveyed to a distance through two different media — air and water. As the velocity of sound is different in the two media, a person at a distance should perceive two blows instead of one. First, the sound would be heard through the water, and then after a short interval the sound should be heard through the air. The time elapsing between the two sounds should depend upon the distance — and be a measure of it.

A fog signal at sea — perceived in this way — would tell its own distance away from the befogged vessel.

The new framework for an aeroplane 25 × 12 ½ shown on p. 609 has just come from Ballauf's. It weighs 7.5 gms. and seems quite strong. The theoretical weight for a frame for an aeroplane of this dimension (at 200 gms. per sq. M. of cloth) is 6.25 gms. (See this Vol. p. 561) The frame is so strong that it is obvious that some of the strips may be reduced in thickness. I would propose to reduce the thickness of the diagonal braces because — as they are riveted together in the middle the total, length of stick without support is only about 13 cm. The end sticks ab, and cd, might also (perhaps) be reduced in thickness because the unsupported length is only about 12 cm., and because in making a cell two 614 end sticks will come together, thus doubling their thickness. The long sticks ac and bd have an unsupported length of 25cm. and hence should be thicker than the others, or wider. Will try a frame in which ab and cd will be 4mm. wide and 2mm tick, diagonals 4mm. wide 2mm. thick, the long sticks ac and bd, will be 3mm. thick and whatever width we can give them so as not to exceed in the whole 6.25 gms. in weight. The above letters refer to the following diagram: —

615

1902, March 7 Friday At 1331 Conn. Ave.

In pursuing the details of a frame like that described on pp. 573 to 578, also pp. 609 to 611, it would be advisable, perhaps to screw the triangular framework to the cross bars or posts, if metallic screws could be obtained that would not add too much to the weight, I have obtained specimens of brass and steel screws of suitable dimensions, and have weighed them with the following results: —

WEIGHTS OF SCREWS.

(As determined by Mr. Zable).

MATERIALS LENGTH IN CM. DIAM. IN CM. NO. OF SCREWS WEIGHT IN GMS. AVERAGE WEIGHT PER SCREW. Brass 2.5 .25 145 154 1.062 gms. Steel 2.5 .20 140 103 0.735 gms. Brass 1.9 .20 144 95 0.659 gms. Steel 1.9 .20 146 66 0.452 gms.

Specimens of wood were secured by Mr. Zable February 21, see p. 586. These were cut into sticks each 100 cm. long, 1 cm. wide, and 1 cm. thick. A table giving the weights of these sticks is given on p. 586, but the balance employed was not very sensitive. A new balance was therefore purchased and the following table gives the result of five determinations of weight at different dates. The new balance is sensitive to a small fraction of a gramme (1/10th).

616 DATE ASH BASS WOOD BIRCH CEDAR CHERRY CHESTNUT Feb.25 57.5 42.6 74.0 54.0 56.3 46.5 Feb 28 58.0 42.9 74.5 54.3 57.0 46.3 Mch 1 58.1 42.8 74.6 54.2 57.0 46.1 Mch 3 57.5 42.4 74.1 53.7 56.8 45.6 Mch 4 57.0 41.9 73.3 53.4 56.4 45.2 Summation 288.1 212.6 370.5 269.6 283.5 229.7 Average 57.6 42.5 74.1 53.9 56.7 45.9 CYPRESS HICKORY LINWOOD MAHOGANY MAPLE CABINET OAK QUARTERED OAK 53.7 79.7 43.1 50.6 70.1 74.2 59.3 53.7 80.4 43.9 51.0 71.1 74.3 59.8 53.7 80.5 43.8 50.8 71.0 74.3 59.8 53.5 80.0 43.2 50.3 70.3 73.8 59.3 53.2 79.4 42.7 49.7 69.7 73.2 58.8 267.8 400.0 216.7 252.4 352.2 369.8 297.0 53.6 80.0 43.3 50.5 70.4 74.0 59.4 POPLAR CAL. RED WOOD SPRUCE WALNUT WHITE PINE YELLOW PINE 49.2 47.8 39.6 58.9 45.4 71.2 49.5 48.0 40.2 59.5 45.6 71.1 49.4 47.8 40.2 59.5 45.6 71.1 48.8 47.5 39.7 59.2 45.5 70.7 48.2 47.2 39.4 58.7 45.0 70.1 245.1 238.3 199.1 295.9 227.2 354.3 49.0 47.7 39.8 59.2 45.4 70.9

The variations of weight are probably due to absorption of moisture. February 28 and March 1 were damp days. Weather was getting dry by March 3, and March 4 was a dry day. It might be well to take another series of five observations so as to get a more reliable average that can be safely used in calculations. As these sticks contain 100 cu. cm. of wood — the weight of 1 cu cm. (that is the specific gravity) can be ascertained by dividing the average weight by 100 — simply shifting the point two places to the left.

617

Have had a number of wooden frames for the support of an aeroplane 25 × 12½ cm. made at Ballauf's in the hope that it might be possible to make a satisfactory frame of spruce weighing not more than 6.25 gms.

We have at last succeeded after having constructed the following frames, which proved to be slightly too heavy: —

The cross section of the sticks used in frame A was 5 × 3 mm., slightly too heavy. In frame B the sticks were 4 × 3 mm., but the long sticks 25 cm. long, seem to require support in the middle. The frame C (4 × 3 mm.) was very satisfactory so far as strength was concerned, but weighed too 618 much (8L7 gms.). It has however extraordinary strength — rigidity — in every direction, and seemed undoubtedly to be the best model for a frame, but it hardly looked as if the sticks could be reduced in size, only 4 mm. wide and 3 mm. thick. We therefore tried the frame D. This turned out to be about right in weight, but did not well resist twisting. The contrast between the frames C and D was really quite extraordinary. Frame C being well braced in every direction. Calculation showed that if the sticks could be reduced so as to have a square cross section 3 × 3 mm. that the model of frame C would be light enough. I tried the following forms which were made at Ballauf's and reached me today

The outer rectangular part of the frame E was made of spruce sticks having a cross section of 4 × 3 mm. The inner sticks — the middle stick s and the two diagonals 3 × 3 mm.

The frame F was made entirely of sticks having a cross section of 3 × 3 mm. There was no comparison between the two frames in strength and rigidity, the frame F being markedly

619 superior to frame E, which had a marked tendency to twist. Both frames E and F came within our limits of weight weighing about 6.25 gms.

In all these frames the sticks were glued and riveted together, the rivets being of brass.

Mrs. Bell gave me today a specimen of black foulard silk 100 × 70 cm., which weighed 29.3 gms. This proves to be about 42. gms. per sq. M. of surface. It is more impervious to air than the cotton cloth used in our Baddeck kites, and weighs less than one-third as much. The frame F was covered with black foulard silk making a beautiful aeroplane surface, tightly stretched. The silk apparently adding to the rigidity of the whole frame. The weight of the completed aeroplane and frame was only 7.9 gms., which is well within our limit of weight for the light framework of a kite. I have allowed 200 gms. per sq. M. for the light framework; 100 gms. per sq. M. for the supporting surface; Total 300 gms. per sq. M. for the cellular part of the kite. The table on p. 561 shows that for an aeroplane of the size considered (25 × 12 ½ cm.) the frame and cloth may weigh 9.375 gms. This aeroplane and frame weighs 7.9 gms. Allowing 1.475 gms. or 47.2 gms. per sq. M. to be added to the heavy framework. In a kite made of aeroplanes like the above, we may therefore allow 147 gms. per sq. M. instead of 100 gms. for the heavy framework constituting the bony skeleton of the kite.

Feeling that I have reached a satisfactory framework for small aeroplanes of the size considered, I have today 620 written the following note to Mr. Schneider: —

COPY "March 7, 1902. Dear Mr. Schneider: —

The frame for the support of an aeroplane returned herewith is just the thing I want. It comes within my limits of weight, and yet appears to be very strong — wonderfully strong considering the slimness of the individual sticks composing it (cross section only 3 mm. sq.)

I should like to have 100 frames made like this, as soon as possible. Can you or Mr. Ballauf take this, order? If not could you give me the name of some one competent to follow the model and not charge an exhorbitant amount.

I shall probably need about five thousand of these frames before I get through, but won't venture to order more than 100 for the first experiment. Can you give me an estimate of what it would cost to make these frames in large quantified.

Perhaps you could direct me to some one who would undertake to cover the frames with material selected by me.

Could you undertake to make 100 of these frames and cover them for my first experimental model.

Yours sincerely, (Signed) Alexander Graham Bell”.

Have a good deal to note from my Home Notes, but have not time to dictate much more today.

I shall simply say that Mr. McCurdy had some conversation with Mr. Eastman in Rochester relating to celluloid, and how to make a celluloid tube or float. Mr. Eastman, it seems, suggested taking a solution of celluloid in Amyl-acetate and then dipping into this solution a rod of pith. On removing the pith and allowing the wet surface to dry, a thin film of celluloid will be formed all over the pith surface. The rod can then be dipped again and again, thus increasing the thickness of the celluloid layer to any desired extent. Mr. Eastman gave Mr. McCurdy a bottle of celluloid “cement” — 621 which I understand to be celluloid dissolved in Amylacetate. The cement has the consistency of thick syrup — looks like liquid glue — has a very peculiar — and not unpleasant odor.

He also gave Mr. McCurdy a bottle of Amylacetate. I understand this is to be used to dilute the cement to the desired consistenct.

This seems to me to be a very fine idea, and has suggested various ideas to my mind. For example: — Make a framework of any kind that may desired — OF PAPER — then by dipping the paper into the solution again and again we will have it quoted coated with celluloid. We can repeat the dipping process until we get the desired strength.

In drinking lemonade saloon keepers no longer give us straws through which to suck the liquid, but fine paper tubes made after the manner of the old graphophone cylinders — paper spirally wound The paper tubes seem to have dipped in wax, and look very much like straws, but have a uniform bore. I propose trying to deposit celluloid upon these paper tubes, thus converting them into celluloid tubes.

Mr. Zable has today purchased for me a bundle of these paper tubes or straws. He reports that 459 of them weigh 250.1 gms. yielding an average weight of 0.544 gms. per straw. Each straw is 23 cm. long and 5 cm. long and 5 mm. in diam.

I propose trying to quote coat with celluloid strips of paper having the shape of metallic umbrella ribs. If we can get a decent coating of celluloid upon these paper slips, they 622 should — theoretically — form very strong and light frames for the support of aeroplanes, and by their form they are very easily attached together.

It may turn out that celluloid piping can be made light enough to support celluloid aeroplanes. In which case the piping would be preferable because it could be hermetically sealed and thus the whole kite be capable of flotation.

Another idea: — Take an aeroplane of silk or other fabric stretched upon a frame, and brush it over with liquid celluloid. Then, upon the evaporation of the solvent the pores of the fabric should be filled with the celluloid. In fact the whole material should be impervious to air. It would have the strength of the silk fabric combined with the imperviousness of the celluloid.

See Howe Nolisfo 149

AGB

623

1902, March 10 Monday At 1331 Conn. Ave.

The new frame for the support of an aeroplane 25 × 12.5 cm. covered with foulard silk (black), weighs 7.9 gms., see p. 619. The aeroplane surface 25 × 12.5 = 312.5 sq. cm. Flying weight equals 252.8 gms. per sq. M.

Have just obtained four turkey feathers

I estimate that the wing surface of each feather exposes a surface of about 30 × 3 cm., as shown by the rectangle above.

Each feather, therefore has a surface of about 90 sq. cm.

Weight of four feathers 10 gms.

Surface of four feathers 360 sq. cm.

Flying Weight of feathers like these 277.7 gms. per sq. M.

The flying weight of the light frame covered with black foulard silk is less than this. Our frame is lighter than a feather.

The branch laminae of the feather seem to be composed of the same material as the centre stalk or mid-rib — or — vice versa, the mid-rib seems to be composed of laminae amalgamated together. Probably all the same material — a material analogous to the material composing the horns, nails, or claws of mammals.

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THOUGHT.

Will the material of which feathers are composed become — like horn or claw or nail — soft, when placed in hot water. It would be a great thing if we could soften up feathers — make a sort of papier-mache of them, and then, of this material mould the framework — and flying surfaces of a flying machine.

I have sent some turkey feathers down to the kitchen to be boiled in hot water, and will note the result later.

Charles Thompson has brought up the boiled feathers. They are quite soft like and elastic like rubber . I have tied two knots on one of them. The heat of boiling water is not great enough to do anything but render the quills pliable.

Told Charles Thompson to boil them in oil, temperature of boiling oil is very much higher than boiling water. Charles brought the pot up stairs declaring that the feathers had exploded, and were burning in the hot oil. They certainly looked like charred feathers. The whole mass looked as if it were dissolving in the boiled oil. He left the pot up here to cool, and I stirred up the feathers with a piece of iron.

LATER The feathers had have disappeared with the exception of a few fragments like charred bone floating on the surface, and a large heap of black looking material at the bottom. It is difficult to tell whether any of the material has been dissolved in the oil, or whether the charred material has fallen 625 to pieces, and formed a deposit at the bottom of the vessel.

If the material of which the feathers are composed can be softened by heat so as to be moulded — as seems probable — the heat of boiling water is too little for the purpose, and the heat of boiling oil too great.

Can we dissolve feathers in a volatile solvent. If so we can coat paper, or other material with our solution of feathers — allow the solvent to evaporate — when we should have — over the surface — a thin deposit of solid Quill.

Have placed some quills from the turkey feathers in Amyl-acetate (a solvent of celluloid) to see whether the quill material will dissolve in that liquid. A.G.B.

AGB

626

1902, March 13 Thursday At 1331 Conn. Ave.

In spite of the fact that there was a reception at General Sternberg's, and a musical at the White House last evening, quite a large number of gentlemen were present at Mr. Bell's Wednesday evening, last evening, namely: —

Mr. Charles J. Bell,

Dr. Edward Everett Hale,

Capt. Tanner,

Prof Henry

Mr. Bancroft,

Robert Adams,

Mr. Ulke,

Mr. Dall,

Mr. Friedman,

Mr. Bunker

Dr. Stokes,

Mr. G. H. Grosvenor,

Dr. Merriam,

Mr. Willis Moore,

Mr. McGee,

Mr. Wiley

Mr. Clevelane Abbe.

Also the following ladies: —

Mrs. Edward Everett Hale,

Mrs. Graham Bell,

Miss Graham Bell,

Mr. Gilbert H. Grosvenor

Capt. Tanner told a story about a “Real Robinson Crusoe”, and Dr. Hale told how he happened to write “A Man Without a Country.”

Mr. Graham Bell was not present, himself, as he had gone to Northampton to attend the annual meeting of the Incorporators of the Clarke Institution.

Jean Safford, Secretary.

627

1902, March 17 Monday At 1331 Conn. Ave.

Copied from Home Notes, pp. 179–181. Dated 1902, March 11.

" ENERGY VERSUS MOMENTUM or Is the Effect of a Blow Proportional to MV^2 or MV?

It has been found by experiment that a moving fluid impinging normally upon a plane surface exerts a pressure upon that surface that varies as the square of the velocity of the fluid.

1. Fluid moves with a certain velocity and exerts a certain pressure.

2. Now double the velocity of the fluid and the pressure is four fold.

Consider the particles of which the fluid is composed: — (1) In the first case considered — a certain number of particles, moving (on the average) with the given number of particles, moving (on the average) with the given velocity, strike the obstacle in a second of time. (2) In the second case twice the number of particles strike the object in the same time; which would produce a double effect if the particles moved at the same velocity as before — for the body would then receive twice the number of blows in a second. But, each particle (on the average) is moving with double the velocity of the first case — Hence (a) each blow should produce a double effect if the force (or energy) of the blow is proportional to the momentum of the particle (MV); but 628 (b) a four-fold effect if it is proportional to the square of the velocity (MV^2).

Conclusion: —

(a) If a particle moving with doubled velocity produces a doubled effect — the pressure produced by a fluid moving with doubled velocity should be four-fold — varying as the square of the velocity of the fluid.

(b) If a particle moving with doubled velocity produces a four-fold effect — the pressure produced by a fluid moving with doubled velocity should be eight-fold — varying as the cube of the velocity of the fluid.

Experiment shows that the pressure varies as the square of the velocity of the fluid — Hence the effect of the impact of a particle varies as the velocity of the particle simply — and not as its square. It is proportional to the momentum of the particle (MV) not to its energy (MV 2 2 2).

Is this an experimental demonstration of the point?

If the impact pressure of a moving bullet upon a target is proportional to the square of the bullet's velocity — then the pressure upon the target of a continuous stream of bullets (of uniform density or number in is given space) — should vary as the cube of the velocity. Does a bullet moving with a two-fold velocity — produce a four-fold effect? I doubt it.

Not so sure: — Suppose a Maxim gun to discharge a stream of bullets, so many in a second of time. Now let it go on discharging bullets at the same rate as before — but 629 let each bullet move with double velocity, would the target be struck at a greater rate than before? If the gun discharges a hundred bullets times per second, will not the target be struck one hundred times per second whatever the velocity of the bullets might be . Would any greater number of bullets pass any given point in the same time — if the rate of discharge continues the same.

How does this case differ from a stream of water? Surely — in a stream of water — twice as many particles will pass a given point in the same time — and each particle will be moving with twice the original velocity. In this case, therefore — the target would be struck twice as many times as many times in a second — and each blow be twice as hard as before.

2 × 2 = 4 — Total — four times the effect.

If the target should be struck <u>twice</u> as many times in a second — and each blow be <u>four</u> times as hard as before: — Then 2 × 4 = 8 — Total would be eight times the effect.

Think the argument is sound. The experimental result that the pressure is four-fold — not eight-fold — shows that each particle moving with a doubled velocity exerts only a doubled — not a four-fold effect.

A.G.B."

Copied by J.A.S.,Secretary.

630

1902, March 19 Wednesday At 1331 Conn. Ave.

MOVEMENTS DURING THE LAST WEEK: —

Tuesday, March 11 left for Northampton, Mass.; reached there Tuesday evening, March 11.

Wednesday, March 12, attended meeting of Corporation of Clarke School, Northampton, Mass. Spent night at Massasoit Hotel, Springfield.

Thursday, March 13, Saw Mr. Gruver in New York about N.E.A. matters. Went with Mr. Gruver to the theater, saw "The Sleeping Beauty and the Beast". Stayed Thursday night at Gilsey House. Telegraphed to Mr. Allen, Supt. of School for the Blind at Overbrook, Philadelphia, inviting him to lunch at Hotel LaFayette, Philadelphia, on Friday, March 14, at half past one, also invited Booth by telegraph.

Friday, March 14, Mr. Gruver accompanied me from New York to Philadelphia, where we found our rendezvous, the Hotel LaFayette in process of demolition, everything being removed out of the hotel, as it has been decided to take it down and build a sky scraper there. Went to Stratford Hotel. Mr. Booth had joined us at the depot. Mr. Gruver and Mr. Booth kept watch in front of the LaFayette for Mr. Allen, found him, and all turned up for lunch at the Hotel Stratford. Spent whole afternoon on N.E.A. matters. Adjourned to meet again at Overbrook, Penn. on Saturday, March 22. Returned to Washington, Friday evening.

Left Washington Tuesday morning, March 11, returned Friday night, March 14, 1902.

631

The day before leaving Washington, namely March 10, 1902, in a note received from Prof. Langley, he ways: —

“I do not know if I can get away today, but if I can, I will come up about two and see if we can fly that kite together”.

Accordingly at 2 o'clock P.M., March 10, 1902, Monday, Prof. Langley called for me. Mr. Zable drove down in solitary state in Mr. Langley's carriage with our Baddeck kite in charge: — and Prof. Langley and I followed in my carriage. Went down to Analostan Island. Crossed over in a boat, On the Island we found a young man and a boy — two boys, I think — with Prof. Langley's kite

This consisted of a hexagonal frame composed of 12 aeroplanes, each about 50 × 25 cm., carrying in its centre a long stick of square cross section. It looked about 2 or 2 ½ cm. square, and I should think about 2 M. long, projecting in front of the hexagonal body — I should think about 75 cm. The stick may even have been more than 2 M. long. It was so light, however, as to show that it was not a solid stick, but a pipe closed at both ends. The tail consisted of three 632 aeroplanes. As I try to recall them now I should think they were less than 50 × 25 cm., and yet more than 25 × 12 ½. I should think that each aeroplane was about twice as long as it was wide, a rectangular frame on which silk was stretched. All the surfaces were silk surfaces, looking like white taffeta. The tail was opened or closed in varying degrees — automatically by a sliding weight of lead within the hexagonal body

W is the sliding weight attached by a long slip of wood to the tail, and causing two of the tail aeroplanes to open from one another when the weight was moved one way (forwards, I think) and closed when the weight moved the other way. I am not sure whether the horizontal tail aeroplane was moved or not, I think it was fixed. My conception of how the tail was intended to operate is this: — So long as the kite remained horizontal the weight would remain in its normal position, and the tail too; but, if the central rod was not horizontal, then the weight would slide downward opening (or shutting) the tail in a varying degree. I presume that the tail would open more widely when depressed at the stern in which case the weight opened the tail by sliding backwards.

633

It was a very ingenious devise to obtain an automatic control of equilibrium in the air.

Unfortunately, there was practically no wind when we reached Analostan Island. The Baddeck kite flew well when I ran with the string, but there was not enough wind to enable it to sustain itself in the air.

Prof. Langley was very anxious that I should decide where to attach the string in the case of his kite, and test it myself as I thought best. But, with no wind, and a kite of such construction that it would probably be smashed in coming down, I did not like to take the responsibility. The string was attached at about 50 cm. in front of the hexagonal body. Prof. Langley's young man took the string and was about to run with it, but, when I found that he had never flown a kite before, I thought I better take the string myself, so that I could save the kite from injury in falling as much as possible. If a kite does not fly properly, but tends to dive, an inexperienced person running with the string, will drag it into the ground, smashing it irretrievably; whereas an experienced person under such circumstances would instantly release the string, or loosen it, thus reducing the shock of impact. Or again, if a kite is descending tail down, an experienced person can nurse the kite by suitable manipulation of the string so as to reduce the shock of falling to a minimum.

I ran with the string but observing that the kite was not rising, I released the string in time to prevent serious disaster.

We could not make experiments properly on account of lack of wind, and it seemed a pity to smash such a beautiful model as that which Prof. Langley had without obtaining useful 634 results. I recommended Prof. Langley to fly the kite from the top of a pole. He could then study the behavior of the kite without the danger of smashing it.

The young man in charge had forgotten to bring with him a leaden balancing weight, to be placed on the central stick in front of the body.

I asked Prof. Langley for the weight of the kite, and I have received from him in reply the following letter: —

“Smithsonian Institution, U.S.A.,” March 11, 1902. Dear Mr. Bell: —

The peculiar hexagonal kite which you saw yesterday weighs together with the leaden balancing weight (which) was not then on hand), 930 gms.; the six outer planes of the hexagonal and the six inner planes are each nearly 50 × 25 cm., so that in the twelve there are about 1500 cm., the diameter being a little less than 90 cm.” — (Surface 15,000 sq. cm., not 1500. A.G.B.) — “This does not include the horizontal or vertical tail pieces which are not considered as supporting surfaces. If we treat one half of it as supporting surface, we should have about ¾ths of a sq. M. to a little less than 1 kilogram; more exactly, 7500 cm. to 930 gms., or in English measure, 8.6 feet to 2.04 lbs., which is 4.2 ft. to the lb., or 0.237 lbs. per sq. ft.

Very truly yours, (Signed) S. P. Langley."

AGB

635

1902, March 21 Friday At 1331 Conn. Ave.

8 Resume of Dr. Bell's Wednesday Evening 17 for Mar. 19, 260 Apr 2, 1902

By A. G. Bell

Mar 21, 1902:— We had a very good Wednesday evening meeting, 19th inst. Present: Surgeon General Sternberg, General Greeley, Mr. Tyler, Capt. Sigsbee, Mr. C. J. Bell, General Wilson, Dr. Burnett, Mr. Kennan, Mr. Lloyd, (these received special invitations): also present Mr. Zable, Mr. Peters, Frisbee, Dr. Day, Bunker, Friedman, Dall, Mc. Curdy, Darton, Maj. Russell, Willis Moore, Tittmann, Lucas, Chapman, Dr. Wigglesworth Clarke, Briggs, Mathers, Grosvenor McGee, and A.G.B. and I think other gentlemen; total gentlemen noted thirty. The following ladies were also present: — Mrs. A.G.Bell, Mrs. C. J. Bell, Mrs. G. H. Grosvenor, Miss Graham Bell, Miss S. W. McCurdy, Miss Mace, Miss Gertrude Grossmann, Eight ladies. Total 38 persons.

Also Mrs. Day Total 39 persons.

General Greely spoke on the use of the telegraph in the army during the recent war, referring especially to the improvements in communication made under Maj. Russell's charge, in the use of a buzzer and telephone for transmitting and receiving instruments, which had enabled the Commander of the forces to keep right in touch with the firing line, in spite of all sorts of accidents to the lines. The telephone proved to be so delicate a receiving instrument that they were even able to communicate through bare wire, lying on the ground in the midst of puddles and marshes. They were able to get recognizable signals through 25 miles of that wire, and even breaks in the wire of considerable length — several feet — did not stop communication. He spoke specially of the form of buzzer developed under Maj. Russell's charge.

General John M. Wilson then spoke of Maj. Russell, 636 personally. Maj. Russell then exhibited the apparatus used, and worked the buzzer. A great many persons participated in the debate, and the conversation drifted from telegraphy and telephony to wireless telegraphy, in the army and the weather bureau.

Mr. Lloyd spoke of compulsory arbitration between labor and capital in New Zealand, and described the nature of the Court of Arbitration which has been in operation for six years in New Zealand. This led to great discussion, in which one-half or two thirds of those present participated; in fact there was so much interest in the subject that I have decided to have one whole evening devoted to the relation of capital and labor, and have arranged with Mr. Friedman to open the discussion of this subject on Wednesday, April 2.

See p 641

On page 616 is given a table of the weights of our standard specimens of wood, each stick 100 × 1 × 1 cm. The observations were made Feb. 25, Feb. 28, March 1, March 3, and March 4. A glance at the table showed that considerable variations were observed, arising no doubt from the weather. The weights of the sticks being heavier in damp weather than in dry. I have thought it advisable to supplement this table by another series of five observations made on different dates. The following table shows the results of weighing our standard sticks on March 11, 12, 13, 14, 15.

Mr. Zable has noted the condition of the weather on 637 days when observations were made, as follows: —

March 11, Tuesday, fine clear, dry day — no fire in room

March 12, Wed. cloudy, but fairly dry day, no fire in room.

March 13, Thursday, damp morning, no fire in room.

March 14, Friday, fine day, no fire in room.

March 15, Saturday, cloudy day, fire in room.

100 × 1 × 1 cm.

Weights of sticks 100 cm. long, 1 cm. wide and 1 cm. thick made of the following materials

DATE ASH BASS WOOD BIRCH CAL.RED WOOD CEDAR Mch.11 57.5 42.3 73.5 47.5 53.7 Mch.12 57.7 42.4 73.8 47.7 53.7 Mch 13 57.8 42.4 73.9 47.7 53.8 Mch 14 57.4 42.1 73.6 47.5 53.6 Mch 15 57.2 42.1 73.5 47.5 53.4 Summation 287.6 211.3 368.3 237.9 268.2 Average 57.5 42.3 73.7 47.6 53.6 CHE RRY CHESTNUT CYPRESS HICKORY LINWOOD MAHOGANY 56.9 45.5 53.3 79.6 43.2 50.2 56.9 45.6 53.3 79.8 43.3 50.3 57.0 45.7 53.4 80.0 43.5 50.4 56.7 45.4 53.3 79.5 43.1 50.0 56.6 45.3 53.2 79.3 43.0 50.0 284.1 227.5 266.5 398.2 216.1 250.9 56.8 45.5 53.3 79.6 43.2 50.2 MAPLE OAK(Cab) OAK(Quar) PINE(White) PINE(Yellow) 70.1 73.5 59.0 45.4 70.4 70.2 73.4 59.2 45.5 70.4 70.5 73.7 59.3 45.5 70.5 70.1 73.3 59.0 45.2 70.3 69.9 73.3 58.9 45.2 70.1 350.8 367.2 295.4 226.8 351.7 70.2 73.4 59.1 45.4 70.3 638 POPLAR SPRUCE WALNUT 48.8 39.7 59.0 48.9 39.9 59.2 49.0 40.0 59.3 48.5 39.6 58.9 48.5 39.5 58.8 243.7 198.7 295.2 48.7 39.7 59.0

It will be well to sum up the tables on pages 616 and 637, so as to get the mean of ten observations.

FIVE OBSERVATIONS ASH. BAS WOOD BIRCH CAL RED WOOD CEDAR Page 616 288.1 212.6 370.5 238.3 269.6 Page 637 287.6 211.3 368.3 237.9 268.2 Summation 575.7 423.9 738.8 476.2 537.8 Average 57.6 42.4 73.9 47.6 53.8 CHERRY CHESTNUT CYPRESS HICKORY LINWOOD MAHOGANY 283.5 229.7 267.8 400.0 216.7 252.4 284.1 227.5 266.5 398.2 216.1 250.9 567.6 457.2 534.3 798.2 432.8 503.3 56.8 45.7 53.4 79.8 43.3 50.3 MAPLE OAK(CAB) OAK(QUAR) PINE(WHITE) PINE(YELLOW) 352.2 369.8 297.0 227.2 354.3 350.8 367.2 295.4 226.8 351.7 703.0 737.0 592.4 454.0 706.0

70.3 73.7 59.2 45.4 70.6 POPLAR SPRUCE WALNUT 245.1 199.1 295.9 243.7 198.7 295.2 488.8 397.8 591.1 48.9 39.8 59.1 639

GENERAL RESULTS

Weights of sticks 100 cm. long, 1 cm. wide and 1 cm. thick — average of ten observations.

Arranged Alphabetically

Ash 57.6 grammes

Basswood 42.4 “

Birch 73.9 “

Cedar 53.8 “

Cherry 56.8 “

Chestnut 45.7 “

Cypress 53.4 “

Hickory 79.8 “

Linwood 43.3 “

Mahogany 50.3 “

Maple 70.3 “

Oak (Cabinet) 73.7 “

Oak (Quartered) 59.2 “

Pine (White) 45.4 “

Pine (Yellow) 70.6 “

Poplar 48.9 “

Red-wood (Cal) 47.6 “

Spruce 39.8 “

Walnut 59.1 “

Arranged According to Weight.

40 39.8 Spruce

42.4 Basswood

43.3 Linwood

45.4 Pine (White)

45.7 Chestnut

47.6 Red-wood (Cal)

48.9 Poplar

50.3 Mahogany

53.4 Cypres

53.8 Cedar

56.8 Cherry

57.6 Ash

59.1 Walnut

59.2 Oak (Quartered)

70.3 Maple

70.6 Pine (Yellow)

73.7 Oak (Cabinet)

74 73.9 Birch

79.8 Hickory

640 641

1902, March 27 Thursday At 1331 Conn. Ave.

22 March 26th Meeting Mar 27, 1902: —

Good meeting last night, Wednesday evening, 26th inst. Present: —Col. Blount, Cleveland Abbe, Marcus Baker, Frank Baker, L. A. Bauer, Dr. Burnett, Mr. Bunker, Prof. Coville, Mr. Chapman, Mr. Dall, Mr. Friedman, Mr. Grosvenor, Mr. Gilbert Dr. Gill, Mr. Harris, Mr. Robert T. Hill, Prof. Howard, Prof. Lucas, Willis L. Moore, A.W. McCurdy, Mr. Newell, Sur. Gen Sternberg,Mr. Seymour, Mr. Spofford, Mr. Townsend, Capt. Tanner, Mr. Ulke, Mr. Zable, also Mr. VanRiojen, and an entomologist whose name I forget, also Prof. Ewell of Howard University. Mr. Murray and A.G.B. Ladies present: — Mrs. Gardiner, G. Hubbard, Mrs. C. E. Hubbard, Miss Gertrude Hubbard, Mrs. Ewell, Miss Mace, Mrs. Gilbert H. Grosvenor, Miss S. W. McCurdy, Miss M. H. Graham Bell, Mrs. Graham Bell.

Total 32 gentlemen, 9 ladies, 41 persons.

Dr. Frank Baker gave a communication on striated muscular fibers, and the nature of the connection between the muscles and the bone with special reference to flying creatures. His object being to show that we could not determine from the appearance of a bone the size and strength of muscle attached to it. His remarks had special reference to the remains of Pterodactyles, and other extinct flying creatures, The bones of which have been preserved in a fossil condition, whereas the muscles attached to them disappeared geologic ages ago. His special point was that we could not judge from the size of the roughened area of the bone the size and strength of the muscle attached to it. He illustrated his remarks by lantern slides of muscles and bones of living creatures.

642

He was followed by Prof. Lucas, who “took the defence”, and showed that there were other details besides the roughened area on a bone, from which indications could be taken regarding the strength of the muscles attached to it. He exhibited drawings to the same scale of corresponding bones of the wing attachment to the shoulder of several flying creatures — all living, — so that we could see the significance of the shapes of the bones. The bones of the humming bird, and other birds that make very rapid beats of the wings, were shown to be very short in proportion to their diameter; whereas the corresponding bones of the large sailing birds, which rarely beat their wings at all, were very long and slender in comparison with their width. The structure of the bone in the one case (humming bird variety) indicating great muscular strength, and in the other case(albatross variety) little muscular strength. He stated that albatrosses after eating a good square meal were unable to fly, and had to remain floating in the water. Vultures, too, had not sufficient muscular strength to raise themselves from the ground at any time without running for some distance against the wind, and when gorged with food were unable to support themselves in the air — at least this has been observed on several occasions.

Mr. Lucas also showed two new lantern slides of a skeleton of one of the extinct monsters discovered in America, which has recently been set up — I think in Yale College. I understood him to say that this was the first mounted skeleton of this gigantic creature that has been set up with real bones. — The others were plaster casts or composed largely of plaster casts — whereas this complete skeleton was real. 643 It has a most lifelike appearance standing up like a kangaroo, but apparently running on two legs, not hopping, with its body balanced by its gigantic elevated tail.

Mr. Chapman gave a description of a recent survey in the Rocky Mountain regions, illustrated by sixty beautiful lantern slides that were here exhibited for the first time.

see p

644

1902, March 28 Friday At 1331 Conn. Ave.

Copied from Home Notes pp. 197–8, dated 1902, Mch. 20, Mch.20,

J.A.S.., Secretary.

<u>ab</u> and <u>cd</u> we may term the <u>runners</u> — resembling the runners of a sledge — They should be stouter, stronger and heavier than the rest of the frame. The kite will land on these runners — and they will have to bear the shock of first contact with the ground. This whole frame should be solidly braced together — so that when shock of descent comes — and runners glide over ground — or come bang against it — the frame may <u>act</u> <u>as</u> <u>a whole</u> — and distribute the strain over the whole kite. If strain is propagated gradually through the kite — — the first part struck would receive the whole brunt of the blow — which might prove too much for it. By distribution — the shock of alighting will be distributed — and each part receive only a slight strain. Is this right in theory?

Would not elasticity be of advantage?

My present idea is to make the blow a glancing one

Should come down in a nearly horizontal position — If any difference — head should be lower than tail. The runners of the strong part of frame take the ground first — because the strong framework (constituting one triangular 645 section of hexagon) weighs more than similar shaped sections of hexagon — Hence gravity will keep that side down — and the runners will strike the ground first. The strong framework attached to runners distributes the shock throughout the kite — and no part of light frame should receive much of a strain — and no part of the light frame would touch the ground. When at rest on ground kite should rest on runners. This kite is intended as a model to give an idea how the proposed Giant Hexagonal Kite would work.

Elasticity — or GIVE — might be of advantage in the projecting bow — but I doubt if would be of much advantage in the rest of the strong framework which supports the light framework when on ground. Inclined to think rigidity is preferable. Elasticity, by yielding locally to strain, would be apt to produce temporary distortion under gusts of wind — and thus occasion erratic behavior on the part of the kite just at the time when it should act steadily — being STEERED to one side by the distortion. Kite should retain its form under wind stress. Rigidity of great advantage at such a time.

646

Taken from page 199— House Holes

647

1902, March 29 Saturday At 1331 Conn. Ave.

Since returning from Northampton, Friday night, March 14, 1902, quite a number of thoughts appear in my Home Notes which have not been transferred to these dictated notes. Miss Safford has copied upon pp. 644, 645, and 646 the last entries in the volume of Home Notes ending, 1902, March 20. Before putting this volume away, I will look over the entries made since March 14. will ask Miss Safford to copy entries on pp. 170 to 178, as well as she can, in the Home Notes under date 1902, March 15, commencing with diagram in middle of page 170.

The skeleton of a Tetrahedron proposed as a unit structure for Kites.

The importance of the ideas elaborated upon these pages grows upon me; they point out the way I think to make a kite completely of metal. Three equal sticks or rods, or slips of metal, fastened together at the ends, constitute a frame constituting an equilateral triangle.

Even when connected by simple rivets at the corners, this frame is completely braced, requiring no internal wires or braces as in the case of rectangular four-sided frames.

Such frames can be connected together ad libitum, to make a surface

648

Such a compound frame is perfectly solid in the direction of its plane — it constitutes a reticulated surface — a sort of solid net with triangular meshes.

If this reticulation could be carried out in space of three dimensions instead of two, we should have a skeleton solid instead of a skeleton surface.

A skeleton solid that would be perfectly firm in every direction without any additional bracing, and that could be built up into any form that might be desired.

The unit cell for a surface would consist of three rods fastened together end to end, constituting a triangle.

The unit cell for the skeleton solid would consist of six equal rods, fastened end to end forming a sort of skeleton crystal having four triangular faces

A skeleton solid could be built up of elements like these and be perfectly braced in every direction. The whole structure should, theoretically, have the solidity of a solid mass and yet, on account of its great porousity be very light. The elementary rods might be metallic wires of steel, iron, or — if aluminum alloys turn out to have sufficient stiffness — of aluminum alloy.

I am very much struck with the importance of this conception. — the only practical difficulty in its realization being the mode of attachment of the rods to one another.

649

I have a difficulty in drawing a three dimensional frame of this kind, or of clearly picturing it in my mind. It is obvious that the rods will be inclined at an angle of sixty degrees to each other. Twelve of the rods will therefore make — if in one plane — a hexagonal surface like the following: —

Now let us substitute for each triangle of the surface shown above, a unit cell of the skeleton solid

This is about as far as I can go without a model. This form can certainly be built up of rods all of the same length. Considering the original hexagon as a base, we now have built upon it six of our unit cells, and the spices of these cells form six points in the same plane which, if united by the rods, would form a hexagon — but what I am a little uncertain about is this — whether the rods require d to join the apices would be of the same length as the other rods. Are not the points nearer together than the corresponding points of the hexagonal brace. If so, the skeleton solid would not work out as expected.

650

In order to enable me to work out the conception in a model, I have asked Mr. Zable to have a number of triangles made of wire, each triangle having a side of about 10 cm.

I can then tie these triangles together into unit cells of a skeleton solid

We can then tie these unit cells together and study the forms of the resulting structure. A.G.B.

agb

651

1902, March 31 Monday At 1331 Conn. Ave.

(Copied from Home Notes, pp.170–8, dated 1902, Mch.15, J.A.S. Sec.)

Thought : —Make light-firm-solid-frames — (perhaps with self-supporting surfaces) — and consider each frame as a stick — (a compound stick) — Make a giant frame of frames for the support of a giant aeroplane or cloth surface.

Thought : Could not these stick-frames be made of metal.

Avoid rectangular elements — let everything be built up of equilateral triangles. Terminal surfaces will then be at proper angle to make connection with other frames.

Whole thing could be built up into a solid compact form of almost any desired shape.

Umbrella-rib form well adapted for rivetting together

652

If one end closed — other open — such ribs can be fitted together like pipes.

Three such sections a,b,c, would make a complete triangle

Should be possible with three other pieces of equal length to form a solid or crystalline form having four faces — each one an equilateral triangle.

Considering this — as a sort of unit cell — a cellular structure could be built up of almost any desired form. If the elementary lines (or sticks) could be simply fastened together by a rivet, the whole resulting structure would be solid and completely braced in every direction.

Consider first — problem of fastening six linear pieces together by rivets to form a crystalline form having 4 similar faces — each an equilateral triangle.

Letting one point (a) be an apex facing us in the centre of triangle bcd as base. Then < dcb, < bcd, < cdb each = 60°. But angles bac, bad, cad, each = 120° — at least they would appear so — by perspective fore-shortening. Each of these angles bac, bad, cad, would = 60° in their own plane .

653

Can perspective fore-shortening enlarge an angle?

Yes, certainly.

Thought : — As the sticks or rods or whatever they may be — the lines — make constant angles with one another, could not corner caps be made — having places for the attachment of the lines. Such caps could be cast (?) and the rods screw in at the proper places.

Thought : — How many screw holes in a corner cap to admit of ad libitum increase of structure in every direction?

Does not this mean 18 holes? 3 planes, 6 holes in each plane? 6 holes in one plane. Consider six planes cutting one another at centre (really 3 planes) the two opposite in same plane, and six possible in each.

654

Push a thing into a hole out of which it cannot come. Each one may be loose in its hole — and yet — from the triangular construction the whole structure may be solid.

655

It strikes me forcibly that the idea of making a structure composed of triangles of triangles of triangles &c. and ad lib — is a very important idea.

The main point is to find a good form for the unit structure.

We are all familiar with laboratory models of crystals composed of sticks or wires driven into peas.

Something like this is wanted — metallic wires and metallic (?) peas — wires when placed in position not to be capable of withdrawal . Need not fit tightly — but should be incapable of further penetration or of withdrawal.

Thought : — Any way of converting intruded end of wire into a rivet head ? If when forcibly placed in proper hole — end could be flattened — or bent — or changed so that it could not come out — that, is all that is wanted.

Ball and socket joint the idea.

656

Thought : — Examine glove-buttons in search of idea.

Let metallic strips be bent at angle of 60° then they will fit together almost any way. For example: —

Thought : — Would not little angle pieces constitute the only necessary connection. Angle pieces at 60° — to be riveted to slips.

Thought : — Could these be solid triangular pieces.

Or one part solid — rest thin metal

I like this

Could these not be used for attachments — and umbrella rib arrangements of aluminum alloy or other metal (steel) be employed of uniform length and size.

Thought : — Make rods of metallic pipes to be fitted on end of metallic pin. This could be cast

End of pipe could be split so as to give when shoved on.

657

Try slips of pasteboard.

And angles of pasteboard.

Paste slips and angle pieces together.

See whether we can paste six slips with angle pieces so as to make unit cell.

Thought — Let caps consist of hollow metallic spheres with projections to which rods can be attached. Whole arrangement can be made to float.

Everywhere frame constitutes a series of equilateral triangles. Fine idea this if we can find simple mode of attaching the radii to the centres — the spokes to the hubs. If hubs are globes — frame may be of wire and float — or flotation can be increased by making spokes of tubes.

658

Can make giant frame if desired of this sort of basket work arrangement. Parts corresponding to large sticks being built up of wires.

Thought : —Must see some wire-net manufacturers.

Hub and spoke good — if we can get satisfactory mode of attachment.

Only question here is hub . Shall it be a hollow ball. If solid and cast — then how about screw thread. The thread must be cut out separately on each projection.

659 660

1902, April 2 Wednesday At 1331 Conn. Ave.

Pages 651 to 659 inclusive, were copied by me from Mr. Bell's Home Notes dated 1902, March 15, pp. 170 to 178.

Jean Safford Secretary.

661

We are away back on our dictated notes, will glean one or two points from Home Notes, March 17 to 20, that do not seem to have been referred to here — before putting volume away.

Under date 1902, March 17, p. 185, Thought : —

Attaching two aeroplanes to same cross bar by slitting ends of cloth — sort of double could cone arrangement.

Thought : —

Ordinary triangular framework, vertical and double, with cloth zig-zagged in between.

Thought : — Make the triangular face horizontal, and cover the face with silk. The double frame will afford stiffness. A large aeroplane covering the face would be supported at intermediate points as well as at its edges. Idea is: — Triangular part, instead of being vertical and uncovered should be made horizontal and covered with silk: The spaces between the two triangular frames instead of being covered with silk zig-zagged from cross bar to cross bar, to be uncovered and allow the air to blow through and under the aeroplane surface.

662

Sticks forming triangular face are screwed to the cross bars. Do not the holes through the sticks tend to weaken — do not the screws tend to split them open. Would not woven sticks be stronger than straight sticks screwed together.

In a hexagonal kite structure the outside sticks where contact with ground or obstacles may occur, should be made of thicker and stronger material, so as to distribute the strain through the whole structure: — Sledge runners the model. Please copy drawings bottom page 185, showing runners. Also copy drawings on page 186, showing possible use of hexagonal form of kite, as a gliding machine.

Do not think experiments with amylacetate have been noted here. Home Notes, p. 186, under date 1902, March 17, show that experiments were made that day with celluloid dissolved in amylacetate. An aeroplane 25 × 12.5 cm. composed of black foulard silk stretched over a wooden frame was brushed over with the solution of celluloid, and then allowed to dry. I do not think that the result has been noted.

An extremely fine deposit of celluloid has been left upon the silk and in its meshes. The deposit is so slight as not to be perceptible to the eye. That it is there, however 663 is obvious from three facts: —

(1), The odor, (2) the sound produced by the aeroplane when it is tapped by the finger; sounds as though it were composed of paper or metallic foil instead of silk, (3) the aeroplane seems to be impervious to air .

When we cover the mouth with a piece of foulard silk and attempt to blow through the fabric, air passes through the meshes of the silk, but with some difficulty; still there is no difficulty in recognizing that the silk is porous to a certain extent to air. The piece of silk which was treated with celluloid solution as above described appears to be air tight.

The additional weight produced by the celluloid is imappreciable. The wooden frame with its aeroplane weighs about 8 gms.

Copy drawings on page 187 as well as you can, copying carefully drawing with the figures 100 above it.

On Tuesday, March 18

a sheet of artist's tracing linen 51 × 78 cm. was weighed Surface equalled 3978 sq.cm., weight 34.5 gms., which represents 87 gms. per sq. M. of surface. Material perfectly air tight, but the glazing washes out.

664

Washed out piece of Artist's tracing linen Tuesday March 18, Home Notes, p. 192. Some days afterward tested porosity, and found the dry linen practically air tight.

Have not time to dictate any more today. Will ask Miss Safford to copy notes on p. 192 under date March 18, and to copy the drawings above referred to. We may then, I think put away that Volume of Home Notes.

A.G.B.

665

1902, April 3 Thursday At 1331 Conn. Ave.

Copied from Mr. Bell's Home Notes, dated 1902, Mch.18,p.192.

Have washed out a piece of artist's tracing cloth with soap and warm water. The specimen now looks like a piece of a cambric hankerchief. Too damp and wet to test porosity.

There can be no difficulty in making a closely woven fabric — practically air-tight — by coating it with varnish.

The black foulard silk aeroplane seemed to be quite air-tight — with so thin a deposit of celluloid that it was not visible.

Upon tapping the silk surface however, it gave forth a peculiar so und quite different from the silk alone — more like metallic foil.

Will now coat a white silk aeroplane with celluloid cement — and leave it over night to dry.

White silk stretched on frame like that — 25 + 12.5 cm.

N.B. Have also coated a thin piece of China Silk, very light — but too porous to be used without some material to fill pores. Have given it a coat of celluloid cement and have also given the white silk mentioned above a second coating.

A.G.B., Mch.18,1902

Thought : — Coat a wooden frame with celluloid. The sticks may be made very small in diameter and strengthened by being coated with celluloid. The silk or other material — 666 coated with celluloid — will be glued to the frame by celluloid. A.G.B., March 18, 1902.

Pages 665 and 666 have been copied from Mr. Bell's Home Notes p. 192, dated 1902, March 18. Page 667 has been copied from drawings at bottom of p. 185, Home Notes, dated 1902, March 17, and drawing at top of p. 186, Home Notes dated 1902, March 18. Page 668 has been copied from drawings in Mr. Bell's Home Notes dated 1902, March 18, p. 187.

Jean Safford Private Secretary.

667

Copied from Mr. Bell's Home Notes, p. 185, dated 1902, March 17

J.A.S., Sec.

Copied from Mr. Bell's Home Notes p. 186, dated 1902, March 17

J.A.S., Sec.

668

Copied from Mr. Bell's Home Notes, dated 1902, Mch.18,p. 187

J.A.S., Sec.

669

1902, April 7 Monday At 1331 Conn. Ave.

22 April 2nd Meeting Apr 7, 1902:—

Last Wednesday, April 2, we had up for discussion the subject of the relation of capital and labor. Present: —

Mr. Friedman, Dr. Weyl, Mr. Walling, Mr. Zable, Mr. Gallaher, Dr. Swann Burnett, prof. Lucas, Mr. A.W. McCurdy Mr. George McCurdy, Rev. Dr. Hamlin, Mr. Schell, Mr. Ferreri, Mr. Hill of the Geological Survey, the Hon. Mr. Hill of Conn. Mr. Adams, Rep. from Penn., Col. Blount, Prof. Wigglesworth Clarke, Mr. Tyler, Mr. Totten, Mr. Bunker, Dr. Bauer, Prof. Willis Moore, Prof. Howard, Dr. Wines, Commissioner MacFarland, Mr. Chapman, Mr. Kauffmann, A.G.B.

Ladies: Mrs. A. G. Bell, Miss Graham Bell, Miss S. W. McCurdy, Mrs. Edwin Grosvenor

Total, 28 gentlemen, 4 ladies.

Mr. Friedman opened the discussion with a formerly prepared paper, which he read. I will ask Miss Safford to copy the paper as an appendix to these notes. The discussion was participated in by: — Dr. Weyl, Mr. Walling, Dr. Hamlin, Dr. Wines, Mr. Bunker, Col. Blount, Mr. Adams, Mr. Hill, of Conn., Commissioner MacFarland, Dr. Wigglesworth Clarke, and others.

I have just received a typewritten paper without name attached coming in an envelope from the Census Office, which I recognize as the speech of Dr. Wines. I will ask Miss Safford to append these remarks to this dictation after Mr. Friedman's paper.

sup 612 AGB

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Prof. Grosvenor left Washington either Tuesday night or Wednesday morning, for Amherst, Mass. Mrs. Grosvenor remained over Wednesday, and left Thursday morning. She was present at the Wednesday evening meeting. Mr. and Mrs. Gilbert H. Grosvenor, Melville Bell Grosvenor, and nurse left for Virginia Beach Wednesday evening, April 2.

Mr. Fearon, of Halifax arrived in Washington Saturday morning, April 5, and is present while I make this dictation. He leaves Washington this afternoon.

Helen Keller, Miss Sullivan and Mr. Macy arrived in Washington yesterday Sunday morning, April 6. Helen Keller and Miss Sullivan are staying at my father's house, and Mr. Macy at the Volta Bureau.

The new frame body for kite, 300 cm. long × 25 complete with bag finished Saturday, April 5; also a hand satchel containing 100 aeroplanes 25 × 12.5 completed Saturday April 5

Mr. Zable and I leave this evening for Virginia Beach, with the above apparatus.

Mr. C. E. Borchgrevink, the Antarctic explorer is in Washington, and will lecture before the National Geographic Society next Friday, April 14. I propose as President of the National Geographic Society to give him a dinner on Saturday, April 15, at eight o'clock, and am sending out invitations to the following gentlemen: —

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1902, April 12 Saturday At 1331 Conn. Ave.

List of gentlemen who have accepted the invitation of the President of the National Geographic Society, to dine at The New Willard, this evening, Saturday, April 12, 1902, to meet Mr. C. E. Borchgrevink, the Antarctic Explorer.

Charles J. Bell,

Gilbert H. Grosvenor

C. E. Borchgrevink

A. J. Henry

David J. Hill

C. Hart Merriam

Marcus Baker

Henry F. Blount

F. V. Coville

S. H. Kauffmann

Willis L. Moore

Henry Gannett

A. W. Greely

W. J. McGee

Gifford Pinchot

O. H. Tittmann

A. W. McCurdy

Mr. Eastman

Admiral Dewey

Sen. Orville Platt

George Kennan

Justice Harlan

Walter Wellman

Mr. Heilprin

Representative Hill

Secretary Swedish Legation

A. Graham Bell.

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62 20 42 21 Mr. Friedman's Paper

Copy of paper by Mr. I. K. Friedman upon the subject of the relation of capital to labor, read by him at Mr. Bell's Wednesday evening meeting, 1902, April 2.

The old nursery rhyme has it that if all the men, trees, axes and waters of the earth were united, and if the single man heaved the single ax against the single tree — the condition of oneness would stir up considerable of a splash. Well, something like this process of uniting has gone on in the industrial world until we have capital represented in the great trust — gigantic California redwoods of the financial forests — and labor represented in the single ax of unionism. Society is busy in evolving plans which shall prevent the ax and tree from clashing, and so save itself from ducking.

Now this highly organized state of industrialism was predicted and made possible by the marvellous textile inventions of England and the application of steam to the machines invented. The new method of manufacture was introduced in the last quarter of the 18th century. It was a revolution which came so quickly that there was no time for a social readjustment and it was attended by suffering, barbarity and cruelty so severe and terrible that England has not recovered from the blight even today. Factories supplanted homes everywhere, the independent hand producer became part of a machine, the tenement supplanted the home, the overcrowded town and city the healthfulness of country existence, and boys and girls of ten years of age and upwards were taken from school and home to 673 toil in mine and workshop. Immense fortunes impossible before, redounded to the Arkwrights and Peales, coined in part from the shortened lives, stunted growth and moral corruption of an entire people.

Every age would seem to evolve its own evils and its remedies if not its own cures. The evils of the system became so abhorrent that parliament was obliged to interfere with the passage of the Factory laws, restricting the hours of labor, the employment of children and the evils entailed by the new environment. At about this time the labor unions — speaking quickly a recrudesence of the old guild — sprang into existence and began a hard struggle for existence, fought as they were at every step of their development by capitalism, courts and laws of conspiracy.

In our own time, — which brings us to the subject of this evening's discussion — we are the present witnesses of an evolution equally as wonderful, as thoroughgoing and as epoch-making as that which supplanted the tool and the hand by the machine and steam. Of course the engine of the change is that form of industrial organization known as the trust. We have a few groups of men in New York and in Boston and Philadelphia — financial suburbs of New York — who control the destinies of nine mighty industries, aggregating 20 billions in value; namely, the railroads, the street railroads, minicipal lighting, oil, steel, electrical supplies, railroad equipments, lake and foreign shipping, and lastly, although not least to many, copper. This list is by no means inclusive, for 674 it makes no mention of partial monopolies like those of tobacco and sugar, or of those in the first stages of formative growth; nor is there any reason to suppose, although every reason for the contrary, that this process of trust organization will not assume more massive proportions.

Perhaps the objections to the trust may be formulated as follows, firstly the incalculable authority it confers upon a few men, that these few are becoming oligarchs with a power that makes that of kings and czars small by comparison; and they are building up a machine greater than that of the government, employing more men, expending more monies, and so becoming capable of imposing its will on the weaker will of the government. Secondly that the trust is rapidly crushing out a valuable middle class, that it is limiting the chances of a growing generation of young men. Thirdly that it prevents legitimate competition and by controlling price has the nation at its mercy. Fourthly its ability to juggle with stocks bonds, and the investments of an entire people. Fifthly its power to control wages.

The answer to these objections are ready to hand. One may state that there has been no abuse of power so far, that it is fair to suppose that the interest of the trust will abjure such an abuse, that the middle man and the small producer present a form of wasteful competition harmful to society; that the trust will create wealth for innumerable of its employees and so make a new middle class; that the old laws of supply and demand is being superseded by the newer law of monopolistic price; that in the long run it must treat investors 675 fairly or fail of their support. Lastly we come to the question of wages and labor.

Probably the one definite organized movement, the one recognizing the power of the truths and combining in a definite organized manner to cope with its might, is the labor union. There is a growing socialistic body, but it has as yet no definite organization or aim and so, for the present, they may be dismissed as of comparative unimportance. The labor organization, on the other hand, has a membership of a million and a half men enrolled under The American Federation of Labor, and the number of other labor organizations give the unions an approximate membership of two millions, while its policy is definite and formulated.

The unions recognize that highly organized themselves they can best treat with a highly organized industrial body and there is less and less antagonism to the trust as such on their part. It fully recognizes the fact that it can enforce its demands and obtain fairer conditions from a corporation like The United States Steel than from a body of unorganized employers like those controlling the textile industries. It is fair to say too that the trusts have not diminished wages. It is also recognized that the shorter hours and higher wages which the unions impose are of great benefit to their employers, for every time that hours are shortened or wages increased it means the necessary improvement of the methods of manufacturing processes to compensate in turn for the enhanced cost of production.

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The chief arguments raised against the unions are perhaps these: — the curtailing of production by an arbitrary limitation of a member's work; a hostility to the displacement of labor by new machinery; a limitation of the number of apprentices and so a curtailing of the opportunities of the young; the employment of force strikes; the slugging of non-union men during times of lock-outs and strikes.

To these objections it may be answered readily that under its more intelligent direction the unions are less and less prone to limit the individual work that its members shall do during the course of eight hours, recognizing the fact that to handicap production is in the end to handicap labor; likewise, recognizing the economic law that work always makes work, the unions are becoming less and less hostile to the introduction of new machinery, but demanding, on the other hand, that its share of the production increased by machinery shall be in due and just proportion. Labor will answer the accusation that it attempts to regulate apprenticeship by saying that it heges in the learning of the trades with no more difficulties than is imposed by the members of a profession on novices; thus, in most of the states greater and greater educational acquirements are demanded from those who would aspire to the law or medicine. As regards the use of force it will answer that violence and slugging are no more a definite part of its policy than its employment in the United States Senate, for instance. Finally, that cases of slugging are sporadic and on the wane. Lastly as an instrument for a positive moral 677 and economic benefit to society as a whole much can be said in favor of the unions that the time limits of this paper will not permit of discussion.

Taking labor and capital as an entity rather than as two parts of the whole, one may say that the social organism has a definite social problem, which is the satisfaction of the constantly increasing and higher wants of all its member; and that waste of any kind, be it material or physical or moral, is antagonistic to the complete satisfaction of such wants.

A solution to this social problem — a solution that will confer upon each member of the social organism that part of the general social production which is rightfully his — is found in the socialization of public utilities, like the railroad and telegraph, in fact of all industries amenable to the law of increasing returns. In so far as the organizations of labor and capital are making towards that end — the one in organizing industry for state and municipal control, the other in preparing and educating its members for an efficient membership in such an adjustment of society, in so far as these institutions are making for that end, the newer school of economists recognize in them a genuine social validity.

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at Wed. enduring meeting — Apl. 2, 1902 62 16 66÷ 23 AGB

LD Remarks of Dr. F. H. Wines on Relation of Capital to Labor, made on Wednesday evening, April 2, 1902.

Dr. Mines's Paper.

When the struggle between organized capital and organized labor, and the methods adopted by the master spirits in each of the two warring camps force themselves upon my attention, I am always reminded of the reply made by a gentleman who was reproached for being on the fence made by a gentleman who was reproached for being on the fence in politics. He said: “It is the only clean place”. And yet the imperfection and selfishness which characterize all human action, however well meant, ought not to awaken in any fair mind a prejudice which would prevent us from making an effort to understand what is involved in the question and to arrive at a definite conclusion regarding its merits.

There is a single remark which I feel like making upon this occasion. Modern Europe, as Guizot has said, in his general history of European civilization, is born of the struggle between the different classes of society,—between the partisans of monarchy, aristocracy, democracy and theocracy, as the dominating principle of existing governmental institutions. America has inherited the civilization of Europe; but its peculiar situation and conditions have imparted to the later phases of the struggle of which Guizot speaks a character more or less unique. It is here, I think, that the destiny of the world is to be decided rather than in Europe. The first century of our national existence was a period of conflict 679 2 between two opposing types of social organization. The question at issue was whether the dominant type should be that of a landed aristocracy or an industrial democracy; and incidentally whether the labor required for the development of our material resources should be performed by a class of slaves attached, through their masters, to the soil, or by a class of wage-earners under a legal code of which freedom of contract is an essential feature. The Te Civil War decided that issue. It was a struggle between two incompatible industrial systems. All political issues involve economic principles and economic questions, because they involve the determination of the proper and equitable distribution of the joint earnings of capital and labor, are essential phases of the industrial question. The industrial question therefore is the essential political question. Since the overthrow of slavery it has assumed a new form. The struggle is no longer one between two incompatible systems, but rather how shall the victorious system, the wage system, be equitably, righteously organized, in the interest of both capital and labor. Not only what is just as regards the distribution of profits, but what is right in respect to the division of control of manufacturing plants and the capital invested. Shall the laborer have any voice in the organization and conduct of the industry in which he is employed?

The historical analogue and prototype of the trades union, it seems to me, is found in the free cities of the Middle Ages. The burgesses of those cities had not the social 680 position, the intellectual culture, the political power, the spirit of initiative which belonged to the nobles, the feudal barons. But they had a common interest, and were able to act in defense of their liberties as a unit; and this community of relation and interest extended beyond the narrow limits of each municipal corporation, so that when the great revolt of the free towns against their lords occurred in the twelfth century, although not preconcerted, and without organization, it resulted in the enfranchisement of the commons and the creation of the third estate. This was the splendid service which the free cities rendered to the causes of human freedom and modern civilization. I think that the hope of the preservation of our liberties resides in the trades-unions. This is intended as their existence is a protest against the plutocratic spirit, the tyrannical exactions, the mercenary oppression into which the possession of great and rapidly increasing wealth and power inevitably betrays the members of a ruling class. The trades-unions require to be educated, not abolished; reformed, not destroyed. Their disappearance, under existing conditions, would be the removal of an indispensable barrier against the encroachments of capitalistic monopoly, which is merely another name for political despotism; and it would sound the death knell of our free American institutions. With their overthrow would vanish the altruistic hope of the Twentieth Century, not for us only, but for the entire civilized, industrial world. 2.5

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1902, April 29 Tuesday At 1331 Conn. Ave.

Have not dictated anything since Monday April 7, when I noted p. 670 "Mr. Zab le and I leave this evening for Virginia Beach", &c. A good deal has happened since then, and it may be well to put down events that I can recall.

1902, April 7: — Left Washington by Norfolk steamer about 6.30 P. M.

1902, Tuesday April 8: — Arrived Norfolk, Va. early in the morning. Mr. Zable was carried off by the steamer after he had entrusted the three hundred centimeter body of our new kite to a colored man on the pier. This had been put into a bag, and Mr. Zable had fastened to one end of the apparatus a few green twigs from a tree, so the colored man was very careful to hold the tree upright

After landing his baggage, Mr. Zable had stepped on board the steamer for something he had forgotten, and while he was on board the steamer moved off for Portsmouth, where it would remain an hour or so and then come back. I took a carriage to the Virginia Beach depot and took charge of Mr. zable's baggage, but the colored man in charge of the kite told me that the young gentleman had told him that he must not leave that 682 tree until he came back to claim it. He roared this out from the steamer as it was going off, so I had to take the colored man off with the tree, and left him in charge of all the baggage at the Virginia Beach depot, while I took a drive, and incidentally hunted up Mr. Zable. He hailed the carriage in one of the main streets in Norfolk, so the party was re-united. When the steamer reached Portsmouth he left it and came across to Norfolk on a ferry boat, and was just on his way down to the steamboat landing to claim the tree when he recognized me in the carriage.

I had 100 aeroplanes, 25 × 12.5 in a hand satchel, which attracted no attention at all

The people at the depot, however, were much exercised over the tree. Mr. Zable was asked what sort of a tree it was that was wrapped up so carefully, and where he was going to plant it on Virginia Beach.

We reached Princess Ann's hotel in the early afternoon, and spent the afternoon and evening in building up our kite, attaching the aeroplanes to the body so as to make an eight called hexagonal kite

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In reference to this kite I find the following note in my Home Notes, under date Thursday, April 10, 1902, p. 36: —

“Arrived here Tuesday April 8 — worked till eleven P. M., but could not finish setting up sections of hexagon kite with Mr. Zable. Sent him to bed — intending to get up in the middle of night and complete arrangements before day break — but electric light went out before midnight — so could not commence until after day light. Found there was more than I could do alone — so roused Mr. Zable, but we could not finish arrangements before eight o'clock” (Wednesday April 9) “by which time hotel was awake — plenty of people about and little wind — so did not dare risk experiment”.

On same page p. 36, under date April 10, appears the following note: —

“Last night (1902, April 9) stayed awake nearly all night waiting for dawn. This morning (Thursday) soon after dawn awakened Elsie and Bert — and Mr. Zable — to try kite —

wind or no wind — before visitors were around. Found it was a case of no wind — and did not care to risk apparatus, so went back to bed

Wednesday, April 9, Up at dawn. No wind, could not try experiment.

Thursday, April 10: — Up at dawn. No wind, couldn't try experiment.

Friday, April 11, up at dawn. No wind, couldn't try experiment. Elsie and Bert and baby and nurse left for Washington. I determined to remain over till next morning on chance of wind. In the afternoon drove southwards along the beach as far as life saving station No. 4.

Saturday, April 12. Up at dawn — no wind — couldn't try experiment. Left for Washington at half past eight in the morning, leaving Mr. Zable behind.

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Made train connections at Norfolk, and Richmond, and reached Pennsylvania depot, Washington, about half past three in the afternoon. Attended banquet to Borchgrevink in the New Willard Hotel the same evening:

Present: — Commander Borchgrevink, Sen. Platt of Conn. Gen. Greely, Mr. Eastman of Rochester, Dr. Hart Merriam, Mr. Pinchot, Gilbert H. Grosvenor, Prof. Coville, Mr. Kauffmann, Mr. Henry Gannett, Mr. Walter Wellmann, Assistant Secretary of State (Mr. Hill), Admiral Dewey, Vice-President McGee, Justice Harlan of the Supreme Court, Read-Admiral Melville, Mr. Chas. J. Bell, Mr. Tittmann, Mr. Arthur W. McCurdy, Col. Blount, Sec. Henry, Prof. Marcus Baker, Prof. Heilprin of Philadelphia, Mr. George Kennan, Mr. Willis Moore, Mr. Hill Representative from Connecticut, Mr. Hauge (Secretary of the Norwegian Legation.) The following was the arrangement, of the table.

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At the conclusion of the banquet I said a few words of welcome to Mr. Borchgrevink and the other guests of the National Geographic Society, and appointed our Vice-President, Prof. McGee as Toastmaster. The following were the toasts given, and the names of those who were called upon to respond:—

1. The President of the United States — Justice Harlan

2. His Majesty, King Oscar — The Sec. of the Norwegian Legation.

3. The Navies of the World — Admiral Dewey.

4. Our Nation and Others — Senator Platt.

5. The Explorers of the Ends of the Earth.

Rear-Admiral Melville

General Greely

Walter Wellmann

Commander Borchgrevink

6. The National Geographic Society — President Graham Bell.

Speeches were afterwards made by Hon. Mr. Hill, Rep. from Conn., Prof. Willis Moore, head of the U. S. Weather Bureau, Mr. George Kennan, and Mr. Heilprin.

Sunday, April 13: — At ten o'clock accompanied Helen Keller, Miss Sullivan and Mr. Bok to the White House, where Helen was presented to President Roosevelt and had a very interesting conversation with him. At 11 o'clock left Washington by train for Richmond, caught my connection for Norfolk, Va., where I arrived about 5.30 P. M. The last 686 train to Virginia Beach left at 5.10 P. M., so I was obliged to stay all night in Norfolk all night in Norfolk at the Monticello Hotel.

Monday, April 14: — Finding in the morning that there was little or no wind, so that it was useless to proceed to Virginia Beach for the purposes of experiment, remained in Norfolk until in the afternoon. Left Norfolk 3 P. M. for Virginia Beach. Found Mr. Zable at the Princess Anne Hotel in considerable distress on account of my non-appearance. Late in the afternoon it appeared that there was sufficient wind to try our kite. We had made what we termed a “Pilot Kite”, of four cells 25 × 12.5

This was so light that it was obvious that there would be no use trying the large kite in a breeze that would not support the pilot kite. We had tried the pilot kite for a number of times during the previous week, as it was not of such a size or shape as to attract much attention, and we determined not to try the larger kite until we had a breeze sufficient to support the “ pilot ” . In the late afternoon of Monday, April 14, 1902, we found that the pilot kite flew well, so in spite of the numerous visitors at the hotel we determined to try our hexagonal kite. The following memorandum relating to the experiment is copied from my Home Notes, dated 1902, April 14 Monday, at Va. Beach, p. 40: —

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(Copied from Home Notes, 1902 Apr. 14, Monday at Va. Beach p. 40.)

“Kite rose unsteadily, swaying from side to side — stern depressed. Conveyed impression of being too heavy for breeze- and swaying probably caused by centre of gravity being too far back. We have weights to load it in front — but it does not have lifting power enough.

Approximate weight of kite 1300 gms.

Surface 3 sq. M.

Flying weight 433 gms. per Sq. M.

A few witnesses of experiment. It did not attract as much attention as I expected. An interested small boy helped us — and three or four gentlemen looked on.

Experiment 3: —

Tried flying by bow. Steadier in air, but would not support itself.

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"N. B. The space between adjoining hexagonal cells is only 12.5 cm. There are eight such cells. Mr. Zable is now arranging it into a six celled kite, with spaces of 25 cm. between cells. I will calculate flying weight of new arrangement.

WEIGHTS

Frame 670 gms.

54 aeroplanes at 8 gms 432 gms.

18 silk aeroplanes no frames <u>28 gms.</u> (say)

1130 gms.

1150 gms. (say)

<u>SURFACE</u>

6 × 12 × 312.5 cm. = 2.25 sq. M.

<u>FLYING WEIGHT</u>

2.25: 1:: 1150: × 511 gms. per Sq. M.